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THE

# JOURNAL

OF THE

## MYSORE

## AGRICULTURAL &

## EXPERIMENTAL

## UNION



Vol. XVII]

1937 r.p.56

[No. 1

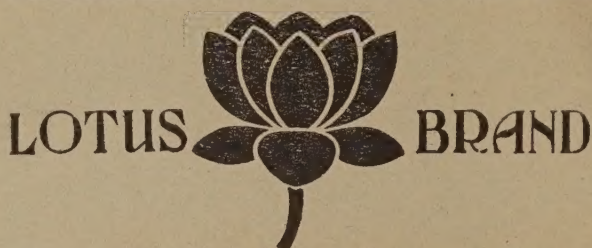
### PRINCIPAL CONTENTS

Coffee—

By Mr. Douglas Meppen.

My First Experiences in Farming—

By Mr. B. V. Venkatacharya, B.Sc. (Agri.).



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Coffee

By

Mr. Douglas Meppen

Rising from a plateau on the Western side of Mysore about 20 miles from the Western Ghats, are a range of horse-shoe shaped hills now known as the Baba Budan Mountains, named after a Fakir, but which formerly bore the romantic name of the *Chandra-drona Parvata* or the Mountains of the Moon.

About 300 years ago, Baba Budan, the Fakir, on his return from a pilgrimage to Mecca, settled down in a cave on the inner slopes of the 'horse-shoe', leaving his disciples at the entrance, saying it was a short cut to Mecca. He disappeared down the passage and never returned. This cave has become a very noted and holy shrine (called the Mecca of the South) and is visited by Muslims and other pilgrims from all parts of India.

About 150 years ago, one of Baba Budan's disciples brought from Arabia, certain berries called *Boon* (the Abyssinian name for the berries of *Coffea arabica*) and planted them somewhere round the cave. The progeny of these trees are said to be the progenitors of old Mysore coffee. As the use of the berry as a beverage became known, very

soon the growing of the *Boon bija* (as it was then called) spread all along the Western Ghats and it was put down in almost all *Hitloos* (cottage gardens) surrounding most of the houses in the *Malnad*.

The plants taken from the neighbouring *hitloos* were just stuck into the ground in groups of 3 and allowed to grow up to any height. When the greater proportion of the berries turned red, they were stripped off the trees by bending them down. The breakages in this process acted as a kind of pruning and the broken stems and branches were removed. This system was called *Nati* (local) and was the only system until Europeans took up the cultivation.

In the early years the produce was handed over to the Durbar (Government of His Highness the Maharaja) and the grower got half the value—between Rs. 2 and Rs. 3 per maund. Later the Durbar took half the produce; this was again altered and the Durbar collected Re. 1 a maund, a sort of export tax called *halat*. The *halat* was subsequently reduced to 4 annas a maund, which continued until the Revenue Survey came in and the land was taxed at Rs. 1-8-0 for permanent tenure and Re. 1 for temporary or 30 year's tenure. This land tax was recently increased to Rs. 1-4-0 for temporary tenure as the price of coffee had gone up abnormally after the War.

Mr. Jolly, an agent of Messrs. Parry & Co., of Madras used to buy the produce from the Durbar and subsequently, through his agents, from the growers. The ruins of Jolly's bungalow are still to be seen on the eastern lower slope of Ratnagiri, above the Kempanhally village.

The officers of the Mysore Commission were the first to take interest in the cultivation of coffee in Mysore.

About 1840 one of the Deputy Commissioners of Shimoga planted some land near Mandgadde—but nothing came of it.

Later, Jolly joined Cannon (nephew of Colonel Cannon). Cannon Onslow of the Commission bought up and amalgamated several *hitloos* round Busgode and Myleenoney.

At Jolly's death, Cannon carried on, enlarged the properties and opened Balur. Fred Green (a nephew of General Green of the Commission) who was said to have been in the Navy, opened "Igur" in Manjarabad. Fred D. Meppen, who was opening a cotton farm for Government at Kadur, opened "Yemmay Doddi" below the Madagad tank, found the rainfall and climate did not suit and opened "Kelagoor", west of Balur and later "Arabidakool".

The Andersons, Dentons and Gaskels opened at Agumbi.

The great idea at that time was that the coffee plant would only thrive under dense shade and with a heavy rainfall.

The gardens at Agumbi failed as the sub-soil was a dense impervious laterite. The Andersons went to Manjarabad and opened a plantation, the Dentons took up land on the outer slopes of the Baba Budans—"Sampigay" and "Hoskan". The Gaskels stuck on until they went home in the 70's.

Ross Porter (son of Colonel Porter of the Commission) opened in Koppa and Santaveri. Some of the Christians in the 70's opened land in the Jagar Valley and Jose Coelho opened Katlay Kan in the Jagar Valley on the inner side of the Baba Budans. Non-resident Indians took up large areas and sub-let the land to cultivators on what was known as "Shikmi" or "Panchshare" tenure, that was giving the owner of the land one-eighth of the produce.

In those days land, very rich and fertile, was granted free by Government; no manure was required, and there was no land tax to pay (the buyer of the produce generally paid the *halat*). Labour—practically all Mysore coolies—was cheap (3 as. and 2 as. a day) and worked from dawn to dusk. Pests and diseases with the exception of *Koleroga* were unknown. Very few Indians took up land far from the villages, but the Europeans opened up the outlying Kans, evergreen forests with a heavy rainfall.

In opening a new garden in those days only the hollows and ravines were planted, all ridges left severely alone, only

saplings that could be cut with a *kadakatti* (a kind of bill hook), removed. The only so-called cultivation was weeding, digging—a persistent and annual work, picking, curing and pruning. Heavy crops were produced in alternate years and the coffee plants were heavily pruned after the big crop.

Lining was done by a cooly walking up or down the land with a nine foot stick marking where plants were to be stuck in. Pits were not excavated to stick in the plants. A crowbar, very often a stake cut from a *Bagani* tree (*Caryota urens*) and sharpened was used and plants collected from some neighbouring *hitloo* were jobbed in. Work began about or after the Gowri feast (September) when the labour came in and continued until the *Ugadi* (Lunar New Year) when coolies being paid off left for their villages. The planter himself generally went to Bangalore to spend the monsoon.

There were very few roads in the *malnad*,\* the few being Bangalore road through Hassan, joining the Shimoga-Tarikere road at Chikmaglur and continuing to the Boon Ghat road. The latter was called the “Boon Ghat” after the old name of coffee as all the coffee went down to the coast by that Ghat, and most of it went down by pack bullocks. In Manjarabad the Bisti Ghat was used.

In the Kadur District in about 1873–74, the road from Balur to Kalsa and in about 1882 the Chikmaglur-Koppa road were opened.

Most of the planters got all their year's supplies by country carts coming up for coffee and the supplies were carried up by coolies or pack bullocks to the estates from the nearest cart road.

In the good old days one travelled by *palki* to Bangalore. The Amildar issued a *rahadari* (permit) and 8 coolies were ready every 5 miles to jaunt you along the road with more or less rowdy songs with a howling chorus.

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\* Mysore State is broadly divided into *malnad* or hilly country and *maidan* which is a comparatively level country.

Later on, the Government subsidised the Patels (the village head-men) of the roadside villages to keep bullocks ready on receipt of the *rahadari*, to trot the old bullock coaches for 5 miles when they were relieved. Roads were not safe on account of dacoits and wild animals and no one travelled by night but stopped at the travellers' bungalows which were well-furnished with 3 or 4 servants attached to them.

In about 1872 Leaf Disease (*Hemelia vastatrix*) broke out and ran through the Mysore estates like a wild fire. The once deep green fields of coffee turned then into a poor variety of yellow spotted crotons, soon shed all leaves and crop and became a mass of sticks.

Leaf Disease first started in Ceylon and Java and when it was followed by the green bug (*Coccus viridis*, Gr.) in Ceylon, coffee had to be abandoned. The Ceylon Government offered a big reward for a remedy and all kinds of washes and fads were tried and the reward claimed for a cure. One remedy was a pair of scissors which cut out the circular patch of yellow spores, another was of placing cups of carbolic acid in the lines of coffee; the fumes were supposed to kill the fungus.

In the early 80's a cricket team from Mysore went to play Coorg. A few of the players (planters) were struck with the robust and disease-free coffee plants and started getting seed from Coorg. Mysore estates were all under more or less dense shade. Coorg estates were planted in the open. Mysore was practically free from the attacks of the Borer Beetle (*Xylotrechus quadripes*). Coorg suffered severely from the attacks of the beetle which laid its eggs under the bark during October, November and December, and the young grub bored into the stem of the plant and either killed it or made it practically useless. As much as 40% of the plants had to be removed and burnt on some estates. Owing to the Mysore system of coffee cultivation under shade (practically the only country in the world to do so at that time), Mysore was almost free from the borer.

On the introduction of Coorg seed (said to be the progeny of the Mysore plant), it was found that the plants would hardly give any crop under the Mysore dense shade. Therefore shade trees had to be removed or thinned out. As nothing was known, at that time, of the nature or character of the Mysore shade trees, indiscriminate cutting of good, bad and indifferent trees was carried out and it was found that coffee declined to grow under certain trees shedding their leaves at the wrong time. Borer flourished under others and became a very serious pest. Cultivation under shade became an art but the introduction of the Coorg variety of *Arabica*, saved the coffee in Mysore.

With the introduction of seed from Coorg (the name of Boon changed to coffee and the old Mysore called "Chiks") most, if not all, of the European estates were replanted with the new plants. When first introduced the plants were free from Leaf Disease but soon lost their immunity. The difference in the character of the bean of the Coorg coffee was soon noticed. The old Mysore coffee had the silver skin (a thin coating under the parchment) ingrained in the coffee bean. The Coorg bean was naked and the silver skin did not adhere but was loose. The brokers in London found out the difference and the ingrained old Mysore always got a higher price.

It is about 50 years since the Mysore estates were replanted and renewed. It is now evident that it must be done again with an improved plant.

In about 1914-15 Mr. Kent of Kegauni and Dodden Gooda noticed some heavy bearing and wide spreading trees, and among some of his Coorg plants noticed eight particularly of a dark colour. By netting these plants for a pure strain he developed what are known as *Kent's Arabica*, at present the best variety of coffee we have and undoubtedly a descendant of the old Mysore's or Chiks. The brokers in London recognised Kents as of the old Mysore type.

An inferior variety of coffee was introduced from Java. Robusta coffee has been and is largely planted all over

Mysore. Originally planted in Java as a catch crop under rubber, it was said to be a heavy and persistent cropper; there are several varieties, all being called Robusta. Among these the Uganda, a long-leaved variety, is said to be the best bean crop up to about 3,000' altitude, the other varieties with broad leaves do not crop well over 2,500'. The price of Robusta is about Rs. 80 to 100 a ton lower than Mysore, but the quantity is said to make up in prices and yields for quality.

Liberian coffee, a large coarse bean, was tried in the 80's as being prolific and a hardy disease-proof tree. High prices were paid for the seed and 10*sh.* 6*d.* to £1 was paid for plants from Kew. The Mysore Government distributed it under the name of "Siberian Coffee". The cultivation soon went out of fashion as it was found to be inferior in quality and very hard and troublesome to pulp and cure.

A very fine variety (or sport) of coffee known as "Margogyne" was introduced from one of the provinces of Brazil. The leaves of the plant were large and crinkled at the edges. The bean is very fine and large and of good colour but the plant is a very shy bearer. Margogyne has been sold in the London market at £200 a ton. It has not paid to plant it on a large scale but the beans on plants in the neighbourhood are said to be improved when cross fertilised by the margogyne.

Many varieties of hybrids have been produced, chiefly with Liberian, but none has proved a satisfactory cropper; some are absolutely sterile. When they do crop, a large percentage, as much as 40%, are malformed beans. Mr. Jackson of Coorg planted a place on the borders of Mysore and Coorg with a very promising Liberian-Coorg hybrid but the plants never came on in Mysore.

Some of the best work of the Coffee Farm at Balehonnur is in connection with plant selection and breeding and there is every hope of producing a leaf-disease resisting plant.

In this connection Mr. Wilson Mayne's researches on

coffee, fungi and other relevant matters and other Departmental bulletins are of incalculable value to planters.

The Coffee Farm is a much needed want but it is unfortunate that it has never had a planter on the staff. If our usual planting routine and methods were carried out, science could show us where we are wrong and teach us the right way; it would then be of great assistance to the planter. They are trying to find what they don't know but not what the planter wants to know, *i.e.*, how to make the ten hundred-weights of blossom that blows stick on the trees, the cheapest and best manure to apply and when.

It is impossible to lay down any hard and fast rules for the cultivation of coffee in Mysore. Latitude, longitude, altitude, rainfall, aspect, soil, lay of the land and wind have much to do with what system to carry out.

The most favourable altitude is between 3,000 and 4,000 or a couple of hundred feet higher or lower, provided other conditions are favourable.

Rainfall is one, if not the most, important deciding factor in coffee cultivation. From 60 to 100 inches of rain well distributed is considered best but unless what are known as blossom showers (the north-east rains that fall about March and onwards) are favourable and sufficient, it is practically hopeless to try and grow coffee successfully. Next is the distribution: very heavy and continuous rains and prolonged droughts are not favourable. The rainfall and its distribution appear to be important and deciding factors in the cultivation and over which the planter at present has no control.

The western aspect is considered the heaviest bearing, provided it has proper and sufficient protection and shade. The northern, as a rule requires very light shade and the eastern, protection from the cold east winds. The southern appears to be the most exposed and suffers both from rain and hot sun and requires very dense shade. Where strong south-west and east winds prevail without efficient wind belts, it is hopeless to try and grow coffee.

On the upper slopes of the forest lands, the soil is generally friable but in most cases the character changes to a more or less dense clay. A rich, deep, sandy loam appears to be the most productive and responsive and is the easiest to work. The Baba Budan hill soil, a deep, friable volcanic soil, highly impregnated with iron, appears to produce the highest priced coffee. As a matter of fact, the high-grown Baba Budan estates, combined with the old Mysore plants, get the highest prices in the London market.

The soil of most of the estates along the Western Ghats is of a clay description and the rainfall is heavy.

Lands with an easy slope from 1 in 5 to 1 in 10, and good drainage are considered the best but steep lands with protection give good crops as the sun is able to get under the shade and on to the plants.

The pests that coffee suffers from are Leaf Disease (*Hemelia vastatrix*), Black rot (*Pellicularia koleroga*), Borer (*X. quadripes*), Red borer which attacks the branches, green bug (*C. viridis*), brown bug (*Saisettia hemisphaericum*, Targ.), mealy bug (*Pulvinaria psidii*, Mask.) and in some parts eel worm attacking the roots and Dieback. The lately introduced Robusta variety has in addition, a shot hole borer. Some 4 or 5 years back, *Stephanoderes*, a beetle that bores into the berry, made its appearance, but was not allowed to spread and is now practically unknown. Mysore was the first to introduce a law preventing the import of raw coffee into the State, which the Government of India followed and at present no raw coffee is being imported to India.

After the Revenue Survey came in, the Mysore Government put an upset price of Rs. 10 an acre on land, reserving the right to certain trees and taxed the land at Rs. 1-8-0 for a permanent tenure and Re. 1 for temporary tenure. There is very little land in Mysore available for coffee planting and that only in inaccessible places.

Having got the land, the question of opening it and the cost have to be met. Roughly the jungles are classed as

"Kans", the forest land away from the villages, the wood-ways that surround or in the immediate neighbourhood of the villages and the "Kumris", *i.e.*, land that has been cleared, burnt and some annual crops grown and abandoned to grow into a great variety of secondary forest, a system long forbidden in Mysore. In most cases the kans and wood-ways are heavy forest with very big trees, but with hardly any undergrowth, the clearing of which costs Rs. 2 to Rs. 3 an acre.

The *Kumri* land is generally overgrown with every variety of thorn and scrub, costing anything from Rs. 5 to Rs. 20 to clear and if overrun with lantana, it may cost up to Rs. 50 an acre to get rid of it. The undergrowth is then generally burnt by letting a running fire through or by heaping and burning. The forest trees, retaining the good shade trees, are felled, lopped off, heaped up and burned. In some cases the whole jungle is cleared and is set fire to when dry.

The land is then lined, generally  $6' \times 6'$ , and pits  $1\frac{1}{2}' \times 1\frac{1}{2}'$  dug, filled and the coffee planted some time during the monsoon; the plants are either root plants or from basket nurseries in which the plants have been raised.

There is no question that many improvements can be made on this, the old system of opening land. It is recognised that coffee comes on very quickly, matures and gives a return on burnt land but the land deteriorates, gets exhausted from crop and requires heavy doses of manure to renew its fertility. After underwooding and judicious burning of thorns, etc., in heaps, it is much more economical to save the accumulations of years of leaf mould and humus than to destroy them in a few minutes. After underwooding there remains the work of opening roads and draining the land, lining, pitting and filling and, for choice, making  $2' \times 2'$  deep pits and planting 18 to 24 months old plants.

It is much more satisfactory and profitable to open 20 to 25 acres in the best possible way than to rush through 50 to 60 acres in the season and boast of your achievement.

The seasons are too short to do a big clearing satisfactorily in one monsoon.

Within 2 to 3 years, the plants are topped by removing one of the primaries above 3'6" and the leading shoot. This causes the plant to spread and enables coolies to prune, pick the crop, etc. In 4 to 7 years the plants begin to bear crop and from 7 to 10 are in full bearing. The cost to bring into bearing is anything from Rs. 200 to Rs. 350 an acre. The land is generally heavily dug the year it is planted. The subsequent work on an estate are weeding and keeping the place clean, handling, pruning, picking and curing, shading and vacancy planting and paying taxes and cesses. The expenditure per acre per annum is on labour Rs. 20, on manuring Rs. 50 to Rs. 80, superintendence Rs. 12, crop picking and curing Rs. 80 per ton.

On many estates nowadays spraying with Bordeaux mixture at a cost of from Rs. 15 to Rs. 25 is carried out as a check to leaf-disease and black rot. The cost depends upon the availability of water. Bordeaux mixture appears to have a tonic effect on coffee but if spraying is done, it must be followed by manuring or the result is disastrous.

As a rule coffee brings out a blossom indicating anything from 7 to 10 cwts. an acre but the average crop is between 3 to 4 cwts., some individual blocks and exceptional estates giving as much as 7 cwts. But as a rule 40 to 50 per cent. of the blossom that blows does not set and we do not know why.

Cultivation is suffering from a want of cheap capital. Firms and banks charge from 8 to 10 per cent., *sowcars* and merchants anything from 12 to 36 per cent., and the crop has to be handed over to the firms or lenders. Practically, the crop does not belong to the grower. Consumers are paying anything from 8 as. to Rs. 1-6-0 a pound for raw and roasted coffee respectively and the grower gets about 4 annas.

The demand in India is about 7,000 tons.

On account of the world-wide depression and the unsettled state of the Continental Nations in Europe, the demand and prices for best Indian coffee in the London market has been badly affected. Some of the finer qualities of East African coffee which come into the London market a month or two before ours also affect our prices adversely.

On this account both Indian and European coffee planters have suffered badly from "financial stringency", but it has affected the Indian planters to a much greater extent than the European.

The financial position of the Indian and European planters is very different and very little understood.

Most of the European planters are resident in England and their properties are run by managers in India. As their money is needed in England, parchment coffee is shipped and sold there; the native or pounded coffee is being sold in this country to meet working expenses. By this means they save in exchange. The managers' and in case of resident owners, their own salary is generally a fixed item, funds are available when necessary, in England, at from 5 to 6 per cent.

In the case of the Indian planters the money is required in India and if and when prices at Home are high, they ship their parchment and lose in exchange in getting the money out. They do not fix a sum for management as is done by Europeans but draw on what is required as they have their families with them, their children to educate, marriages to celebrate and constantly recurring ceremonies to perform and in most cases many relatives and others dependent on them. It therefore becomes very difficult at times, when crops are short and prices low, to meet the current household expenditure and to keep up the properties in an efficient condition. Interest on loans for working are high, anything from 8 to 24 per cent., and in most cases crops are hypothecated to the lender and do not belong to the grower who loses all chances of availing himself of a favourable market.

Few Indian planters have a bank balance and I doubt if any have a Reserve Fund. A large number of Indian planters are non-resident and leave their properties to the management and working of low-paid writers, who in many cases have become the owners. The chief coffee diseases that the Indian planters suffer from are Absenteeism, Earth Hunger, going on buying and extending, and bricks and mortar, as they must and will build!

### **Poultry-Keeping as a Subsidiary Industry to our Farmers**

By

**Lieut. A. A. Monteiro, G.B.V.C.**

*Live-Stock Expert, Bangalore.*

Poultry-keeping is an industry of importance and one which has prospects particularly for the poor villager. The increasing attention that is being given to poultry-rearing in India by the Government is an indication of the recognition of the vast potentialities of the Industry.

The local consumption of poultry and eggs, especially in urban areas, is so great that an organised supply of better produce cannot fail to yield a fair margin of profit.

The advantages of poultry-rearing as a side line or minor industry are many and various. The initial investment required is small and the principles underlying the running of a successful poultry farm are so simple that even the village housewife can understand.

A good hen will normally consume about 4 to 5 annas worth of food a month, and will lay big sized eggs worth about 12 annas. So a run of 30 hens will fetch a profit approximating to Rs. 7 a month or Rs. 84 a year without much difficulty. Poultry keeping should therefore attract the attention of the ryots both as a source of profit and as a hobby.

To the ryot, poultry-keeping is distinctly advantageous: for the birds consume enormous quantities of waste products, grains and vegetables that are on the farm, besides devouring

grubs and insects which are a source of danger to his crops. Poultry manure is, moreover, an additional source of soil fertility.

The only serious drawback to poultry-keeping is the danger of contagious diseases which take a heavy toll, but this danger can be averted with a little care and trouble.

Commercial poultry are usually classified as egg breeds, meat breeds, ornamental breeds, and breeds which combine two or more of these qualities.

The White Leghorn can be strongly recommended as a ryot's fowl on account of its being a prolific egg producer, and also on account of its hardy nature. As an egg producer, there are hardly any other breeds to surpass it. It is wonderfully hardy and comes to maturity very early, pullets beginning to lay when they are about 5 to 6 months old. Taking the whole year through, a good hen could be expected to lay as many as 150 eggs as against one-third that number a "Desi" hen lays. The eggs weigh about 24 ounces to the dozen or even less. The Leghorn is a non-sitter and will keep on laying till it goes into moult.

Eggs contain all the nutritive elements of good food, being essentially liquid meat, easily digested, and is among the richest in growth-promoting vitamins. As food producers good hens are economic units when properly managed. The following are some of the points that should be looked for in selecting high fecund birds:—

1. Rather narrow head with sharp bright eyes protruding from the skull.
2. A comb that is fine, but not too large.
3. Stout and short beak.
4. Thin, but not too long a neck.
5. Back wide across the wings but not too long.
6. A short breast bone.
7. Rather short legs with fine flat bone and placed wide apart.
8. A wide cushion.

9. A wedge-shaped appearance when standing erect, and a slope from front to back.
10. Straight pelvic bones, thin and well apart.
11. Medium size birds are better than small or large birds.
12. A sprightly appearance and tight feathers.

One cock is ordinarily enough to mate with 8 or 10 hens. August or September up to the end of January is about the best period for breeding.

Of the two methods of hatching, the natural and the artificial (incubator), the former will suit the small farmer.

The most important feature in mating of poultry is that the pullets or hens, as well as the cockerel must have descended from a good layer. Fecundity can thus be fostered in the flock. Small eggs should be avoided, and for breeding only the females that laid big eggs be used.

Egg production can be increased by careful breeding. As only best performers should be bred from, it is necessary to use trap nests. It is a simple appliance which prevents the hen from wandering off the nest until she is released. In entering the nest, she touches a trigger with some part of her body and this releases a door that has been kept up by a catch. By the use of trap nests, it will be possible to know the exact number of eggs laid by each hen and select the best layers. The best layers can be marked either with a leg band or by punching between the toes.

As mentioned before, contagious diseases are a grave danger, but if the precautions by way of clean housing and good wholesome diet are taken, the diseases may be warded off. Sick fowls should on no account be allowed to mingle with the rest. The research done in this field bids fair to place within easy reach of the small farmer the means to reduce the disease to a minimum.

The resources of poultry breeding in the State are yet unexploited, for it is unfortunately true that much of the local egg market is supplied from outside the State.

It is only when the farmer realises that the investment in and maintenance of a small poultry run of improved varieties are quite within his means that he may be expected to take to it with enthusiasm, thus improving his own lot as well as promoting the general prosperity of the countryside.

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## **My First Experiences in Farming**

By

**B. V. Venkatacharya, B.Sc. (Agri.)**

*Inamdar, Alakere, Mandya P.O.*

I venture to narrate some of my experiences for the benefit of my inexperienced brethren who may have fanciful ideas about agriculture. This note may be helpful to them to take lessons from my failure and emulate my success.

*The Profession.*—How often have I felt that I have been more fortunate than my other educated farmer friends who lack either one or two of the three important requisites which I happen to possess! I live in the village where I practise agriculture; I am young and therefore energetic; and I have had a training in agriculture before I settled in my profession. For, good agriculture is not an old pensioner's job which is usually managed by residing in a town and paying weekly visits by car or train for a few hours. It requires constant treading of fields, watching of crops and cattle, persistent supervision of labour and a thorough knowledge of the art and practice of farming. Youth being the embodiment of enthusiasm and energy is the best one fitted for field-work. And the training in agriculture enables one to control labour better; simply because one knows the particular implement, one can extract better and more efficient work than a lay beginner. The power of discrimination between the right method at the right time and the wrong method, an understanding of the needs of the soil and the crop, a familiarity with the best implements, manures and seeds are all obtained and could be applied suitably to varying conditions and circumstances.

*Life in the Village.*—Yet, to begin with, I was very diffident to live in the village, having spent all my years in towns and cities, diffident to live in the village amidst strangers, with no relatives to help me in times of need, no friend to meet for days on end, no social amenities, no daily post, nothing of the modern “civilized” life. Again I had also a sort of an inferiority complex to practise agriculture in the midst of those who have been at it for centuries.

*The Equipment.*—There was no “Grandfather’s property” bequeathed to me in the shape of ploughs, implements and cattle; nor was there any tradition, based on accumulated experience and inherited by my father which could be easily transferred to me. I had to begin like a “Fresh man” going about to gather necessary information. I had to invest on bullocks, cows, buffaloes, ploughs, spades, the forks and the sickles; and even the ordinary vegetable seeds to bring my kitchen garden into existence. The village itself was new to me. The method of cultivation, the usual crops raised, the amount and distribution of rainfall, the availability of labour in different seasons were all points on which information was wanting when I began my career. One full year I had to spend in collecting facts.

*Study of the Local Practices.*—I left my entire agriculture that year in the hands of my local servants to till as they liked and grow as they did in their own field. I began to note down in my diary, the seasons of growing the different crops, the availability of labour to each operation and the methods pursued in the performance of the various operations with marginal notes regarding any possibility of improvement.

*The Improved Plough.*—The only improvement I did during the first year of my stay was the introduction of the improved plough. As is usual with anything new, my servant put forward all kinds of arguments against the use of such an implement. I brought a demonstration plough from the nearest agriculture depot. When the servant used it, he said that he might be given one to work it in extremely weedy areas in which the plough would completely bury the

weeds and hence a second ploughing might not be necessary. As weeks rolled on after the purchase, from occasional uses, my servant began to use it more frequently, saying that it worked twice as deep as the country wooden plough. My servant has revised his opinion about the iron plough and now, when I ask him to plough a piece of land, he thinks of nothing else but the improved plough. While till two years ago "splitting and gathering" would not appeal to him, now, he believes only in gathering and splitting alternately with regard to those little paddy flats which become uneven by the slightest work of indiscretion.

*The use of Rainfall Chart.*—I drew up a rainfall chart to familiarise myself with the monsoons, the sowing rains, the growing season and the season of harvest of crops, etc., with reference to a 40 years' average rainfall obtained from the Taluk Office. My agriculture before the advent of the Irwin Canal was almost a "gamble with the rains". During the first year I grew ragi on three acres and I obtained only 365 seers of grain—just one seer per day for a year for my maid servant. In fact, my yield was almost a record that year (1931–32) for my village, since, nobody here grew as much as I did on even double the area. The only reason why I fared so well was because of the deep cultivation I had given with the mould board plough which helped the crop and to resist drought to a degree.

But to leave alone the drought which represents an abnormal season, I could form an idea with the help of the rainfall chart, as to when I might expect a heavy rain, normally,—I mean, during which week in the month, though not which day in the week as is forecasted by the weather recorders in an observatory. The chart has been of immense use to me in fixing up my sowing and arranging it in such a way that I get my harvests in a good rain-free season. To give a small example, I failed to raise a good sunhemp crop on my paddy fields for green manure. I sowed the seed allowing just two months' time to ploughing it in, *i.e.*, during the last week of May. Soon after sowing,

I used to get heavy rains which packed up the soil and affected the germination of the seeds; and even those that persisted in germinating were weak and were devoured by the caterpillar. After I prepared the rainfall chart I began sowing the seed two or three weeks earlier, either in the last week of April or in the first week of May and I have been getting good crops of sunhemp since then.

*Cropping Scheme.*—It is not upon growing successful crops alone that the profits from agriculture mainly depend. For, with improved methods of cultivation and the choice of good strains and varieties and a knowledge of the technique of raising crops, the land may be made to yield good crops; but, if the market does not need the crop or if the market value of the produce is very low, even the cost of production of the crop may not be recovered and a loss may result. A similar thing happened in my case. As long as I was growing jola, ragi, chillies, paddy and sugarcane (for which there is ready market in the Sugar Factory located about nine miles from my place), I was not troubled about the needs of the market, nor about the fluctuating prices. Once I thought I could very well grow onion and garlic. The latter was being sold at 4 seers per rupee and onion was almost a household word with any class of people. Under the guidance and instruction of a Hassan friend I purchased good bulbs of garlic and sowed them; prepared a good nursery for onion seeds and transplanted the seedlings in the right time. The crop was good and the harvest too. I took the onion and garlic to the local shandy. The customers flocked to my neighbour, saying that my bulbs were very big and a measure would hold very few. But then the rate was 10 seers per rupee, while I purchased the seed at four seers. Even at that low rate nobody would purchase my five bags of garlic and seven bags of onion bulbs. I had to take them back to the village, pack them in gunnies and despatch them to Bangalore to a commission agent, and accept from him whatever he offered after deducting train fare, hire for cart, loss during transit,

loss as samples to customers, charity, remuneration to middleman, wages to agent who measures and fills bags, shrinkage, brokerage and a hundred other 'ages'! As regards the accuracy of the weights and measures employed by the commission agent, the less said the better. The game was not worth the candle.

Exactly two years ago the Agricultural Department was doing a great deal of propaganda for the introduction of Groundnut, H.G. No. 1 into the Irwin Canal tract. I fell into the temptation and managed to grow it on  $3\frac{1}{2}$  acres. During the harvest period the price was so low as Rs. 4-8-0 or 5-0-0 per candy of 200 seers. I dug out as much as 17 to 18 candies which was all easy. The soil being somewhat sticky, there was good crop of pods yet under the surface. I could not cope up with the expenditure of further lifting up of pods since the bullock and manual labour engaged could not pay for itself from the day's collections. I stopped all further picking. After keeping the pods for 5 or 6 months and preserving them from the ravages of the rats and bandicoots and finding that there was no local demand for the stuff for cash sales, I managed to dispose off the whole lot of it on credit to a ryot, after getting a pronote executed by him, at Rs. 5-0-0 per candy.

After gaining these experiences, I have almost decided never to introduce new crops into my scheme of agriculture, if their future disposal is much given to speculation.

Even in growing staple crops and crops which have a ready market, a particular method or a plan should be followed bearing in mind the quantity of manure available, the rotation that should be followed, the requirements of fodder to cattle and harvesting and disposal of various crops at convenient intervals so that some pocket money is realised frequently for further expenditure. In fact, I have a pre-arranged plan or forecast written up to suit the above conditions. I would stick to the forecast of work and would only deviate when I have ample justification for the change either due to a phenomenal fall in prices or the onset of some

unexpected occurrences. Otherwise, with no premeditated plan, one is apt to become indolent and farming may not be a business proposition.

*Labour.*—Another important condition that should be satisfied in the preparation of the forecast of the cropping is the provision for continuity of work to my labourers, because I have learnt from painful experience that I should maintain some number of casual labourers every day on the rolls in addition to my bullockmen. Of course, for operations like transplanting, harvesting, thrashing of paddy, weeding, earthing up and harvesting of sugarcane and ground-nuts, I require many men and women labourers. For ordinary operations I found it impossible to employ labour whenever I wanted, because, of the difficulty of procuring them just at the time; nor was it convenient to make use of the coolies whenever they were available. Some items of cultivation should be gone through in time and cannot be postponed. Therefore I began to entertain always some additional hands and every one was trained to every kind of the various agricultural operations. But then, giving them work every morning was very troublesome and here is the need for chalking out a good cropping scheme. On rainy days, however, my labourers make ropes for the ploughs and cattle from out of the fibre which is previously got ready extracted from aloe leaves. Succeeding the heavy rains there may not generally be any farm work; but I should not be letting the labourers go, lest they should receive advances from other farmers for work. On these days I give them work, like clearing silt from drains, trimming the sides of the water channels, digging out stones from a stony patch where my plough would not work at all. Usually when I engage a few work-men I would work along with them to increase their efficiency and completely supervise their work when more labourers are employed. As I have noted previously, before the advent of the Irwin Canal, I was raising dry crops with the aid of unskilled labour. Since then, I have been able to train the labour in the various

intensive farming practices connected with irrigated crops and this has given the full scope to master the details of practical work which is essential for getting better and more work turned out from the farm hands.

*Relationship with the Villager.*—Living as I do in the village I require the co-operation and mutual help from my neighbours and ryots. As a matter of fact, I have, on a number of occasions, obtained loans of indigenous implements like the wooden plough, the *chip-kunte*, the *Halube* and the like. I have, in return given them the iron plough, the scraper, the board leveller and the cultivator. I have postponed many times some of my own agricultural operations for a day or two, to enable my neighbours to rush through their work with the available extra labour. As it is a time-honoured practice to lend bullock labour for sowing, hoeing, etc., the ryots and myself have been mutually helping each other. Of late, we have also introduced co-operative transport of sugarcane to the Factory among ourselves. This is very advantageous since a very great proportion of expenditure in the form of cart hire is avoided. For effective prevention of cattle trespass, poaching and stealing one should be in good terms with one's neighbours.

*Conclusion.*—After all, the blunders one may commit are very few in Agriculture, when compared with other businesses and trades; and the losses from agriculture are not enormous, in spite of mistakes. If one goes on steadily, cautiously and perseveringly one can obtain some profits from agriculture. Though the agriculturist may not amass wealth and hoard it in banks, he can lead a decent living, feed his kith and kin and his dependents with a generous heart, be a master of his own time and at the same time lay by sufficient resources for the rainy day.

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## SELECTIONS

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### Necessity for Improvement in Farm Carts

What are the essential improvements required in the farm cart?

Reference should first be made to improved conditions for the labour necessary in the utilisation of the cart. The work of loading and unloading can be fundamentally modified through the construction of the vehicle and of the body work and through the height of the loading platform.

Of still greater importance is the economy in traction power which should result from an improvement in the construction of the cart itself.

On what factors does the traction power of the farm cart chiefly depend?

On a level road, traction power is influenced in the first place by the type of construction and by the load, and in the second by the resistance given by the road to be covered. The resistance of the vehicle itself depends chiefly on the circumference and on the hubs.

If then it is desired to reduce the traction effort for the cart, it is necessary in the first instance to make a detailed study of the construction of the wheels and of the bearings and to seek to reduce as far as possible the weight of the vehicle. This reduction is limited by the maximum of stability which the wagon must maintain in unfavourable working conditions which often prevail in practice. On the other hand, in improving the wheel parts (wheels and bearings), a marked advance has been effected and has brought about an appreciable improvement in the construction of the farm cart as a whole.

*International Review of Agriculture*, Vol. XXVIII, No. 4.

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### Rural Reconstruction

Mr. F. L. Brayne, as Commissioner for Rural Uplift, is waging an uphill fight with no staff or executive power. His work is purely advisory—but he has the Governor behind him. He tours extensively and advises on the co-ordination of the different departments; and departmental heads come to him for advice. According to two Assistant Registrars all the propaganda is being done by the Co-operative Department. Mr. Brayne holds that the Co-operative Inspectors must put social reform and thrift first, economic questions next. Unless

a co-operator has health, a sanitary house and surroundings and capacity for enjoyment or recreation, there is no use in his saving money.

Mr. Brayne tours with models of ventilators, bore-hole latrines, the dirty and the clean village, etc., etc., gives lectures, distributes pamphlets. Commanding officers of regiments are allowing young soldiers to be taught the rudiments of rural uplift. Mr. Brayne is trying to get in the women. Although there are 150 women's societies, there is no woman organiser, no woman above the rank of Inspector. Co-operative Inspectors are expected to do a good deal of rural uplift—this may interfere with their legitimate work but is considered part of it.

But Mr. Brayne admits that, at present, if supervision and control be withdrawn, the old slackness and dirt will return; there must be a keen inspecting staff. The danger is that, with the withdrawal of a keen Deputy Commissioner or a keen Assistant Registrar, the people would go back to their old ways; and this actually happened in Gurgaon, where Mr. Brayne began this work, because the people thought his successor not interested. It was suggested to me that people should be forced to adopt improvements which led to their earning more money, and could only be gently and quietly persuaded to adopt hygienic and similar improvements. All seem to agree that without the strong and continued drive of the Revenue staff, the work of rural uplift will never succeed, however much work the co-operative staff may do. A sudden inspection has found all the ventilators in a village blocked, some being bricked up.

("Impressions of a Visit to the Punjab." By T. Austin, Esq., I.C.S., *The Madras Journal of Co-operation*, Vol. XXVIII, No. 12.)

### **Coconut Nurseries and the Selection of Seedlings**

The importance of raising a nursery for many agricultural crops is well recognised. It is particularly important for the coconut.

Seed nuts should not be planted in the field direct, but a nursery should be raised. This would facilitate easy selection of desirable seedlings, proper watering, control over pests and would prove not only convenient but economical.

A suitable piece of land with good drainage and close to a water source should be selected for the nursery. Sandy soil at least a foot deep is to be preferred. Besides the good drainage facilities it affords, it keeps off white ant attack commonly reported in the coconut nurseries.

The best time to start a nursery is the end of May or beginning of June so as to take advantage of the south-west monsoon rains.

Also it should be remembered that the seednuts which are harvested during the summer months should not get too dry.

The nut with the husk intact is buried in the soil to a depth of three-fourths of its length or flush with the soil, with the stalk end upwards. From various experiments conducted by the Agricultural Department it appears that the best position for planting is the vertical one, in which the germination is the quickest. The spacing to be given in the nursery depends upon the age of the seedlings required, *i.e.*, the length of the period for which the seedlings will be retained in the nursery. For obtaining 9 to 12 months old seedlings the nuts may be planted one to one and a half feet apart. Manuring of any sort is not necessary. Germination will commence in about two months and will extend to the fifth or sixth month. Watering is very necessary when the rains fail and during the hot season. While in loamy soils watering twice a week will suffice, in sandy soils it should be done every alternate day. The seedlings should be examined periodically for beetle and white ant attack. If the sun is too hot and scorching, partial shading by way of thatch may be provided so as to avoid scorching of young leaves.

The seedlings will be ready for transplanting by the commencement of the following year's south-west monsoon rains. Where the soils are light and easily drained, planting may be done at the beginning of the monsoon. In heavy soils and in places where the rains are heavy it is desirable that the transplanting is done at the close of the monsoon as otherwise, water collects in the pits and dislodges the seedlings, due to the persisting nut which easily floats on water. The usual practice is to transplant a year old seedlings. But in some parts of the Presidency three to four months old seedlings are transplanted in the north-east monsoon. This is undesirable for it is not possible to make a proper selection in very young seedlings.

The importance of proper seed selection in a perennial crop like the coconut is well known to all planters. But the selection should not stop with the seed alone. It should be done in the seedlings as well. The question is often asked whether it is possible to judge the bearing capacity of a coconut tree from the nature of the seedlings from which it is raised. This problem is obviously of utmost economic importance to the planter, for the coconut comes to bearing only in ten to twelve years after planting. Intensive studies carried out at the Agricultural Research Stations (Coconut) on the west coast have shown that certain characters of the seedlings are related to the future performance of the palm. Based on this knowledge, it is recommended that seedlings with characters mentioned below should be selected, as they would ensure early and high yield.

1. Early germination of seed.
2. Large number of leaves in the seedlings.
3. The leaflets in the seedlings are united together unlike in the older palms. The united leaflets begin to split or separate at varying ages of the seedling. The earlier the separation the better is the seedling.
4. Short and strong leaf-stalks and closely set leaflets.
5. Thick stem, and
6. Large number of roots.

*The Madras Agricultural Journal*, Vol. XXV, No. 6.

### Extraordinary Development in Indian Sugar Industry

In a note on the production of sugar from cane in modern factories in India, Mr. Srivastava, Director of the Imperial Institute of Sugar Technology, India, sets out the results of the 1935-36 season.

There were 137 factories out of a total of 146 in India operating during the season. Only two factories were brought into commission, as compared with 11 and 55 in the two preceding seasons.

The production figures disclose an output of 912,100 tons of sugar, which is an increase of about 58% over the output of 1934-35, the season of previous highest output.

The increase is attributed to increased acreage under cane, combined with a healthy crop, as a result of which the factories were able to get full supplies of cane throughout the season; also to well-distributed winter rains and the absence of any serious attack of pests and diseases, which helped to keep the cane in good condition till the end of the season, and thereby enabled the factories to prolong the crushing season and get a higher recovery of sugar. A further reason is given in the large increase in the working capacities of many factories.

It would appear that the average cane throughout per 24 hours was nearly 11% higher than in the previous season, while the average number of working days per factory was 126 as compared with 104 in the previous season. The average amount of cane crushed per factory per 24 hours was 568 tons compared with 517 tons in 1934-35. The maximum attained in any factory was 1,807 tons, while the minimum in any factory was 28 tons.

It would seem also that the cane was of higher sugar content than in earlier seasons, as a record average figure of  $10\frac{3}{4}$  tons of cane per ton of sugar was established. Only about 10% of the factories succeeded in making a ton of sugar from less than ten tons of cane,

while some 29 factories each required 12 tons of cane and upwards for a ton of sugar.

The extraordinary development of the modern Sugar Industry in India is summarised in the following table:—

| Season. | Number of Factories<br>producing Sugar<br>direct from cane. | Cane crushed. | Sugar produced. | Percentage<br>Recovery<br>for India. |
|---------|-------------------------------------------------------------|---------------|-----------------|--------------------------------------|
| 1926-27 | 25                                                          | 742,368       | 62,941          | 8.47                                 |
| 1927-28 | 26                                                          | 786,476       | 67,684          | 8.60                                 |
| 1928-29 | 24                                                          | 791,361       | 68,050          | 8.59                                 |
| 1929-30 | 27                                                          | 989,776       | 89,768          | 9.07                                 |
| 1930-31 | 29                                                          | 1,317,248     | 119,859         | 9.09                                 |
| 1931-32 | 32                                                          | 1,783,499     | 158,581         | 8.89                                 |
| 1932-33 | 57                                                          | 3,350,231     | 290,177         | 8.66                                 |
| 1933-34 | 112                                                         | 5,157,373     | 453,965         | 8.80                                 |
| 1934-35 | 130                                                         | 6,672,030     | 578,115         | 8.66                                 |
| 1935-36 | 137                                                         | 9,801,748     | 912,100         | 9.29                                 |

*The South African Sugar Journal*, Vol. XXI, No. 3.

### The Manuring of Paddy in Ceylon

BY

A. W. R. Joachim, Ph.D., *Agricultural Chemist*

Manurial trials on paddy have been carried out by the Department in various parts of Ceylon. The results obtained have not always been the same at all places with the same types and quantities of fertilisers. This is due to the variation in soil, climatic and irrigation conditions, methods of cultivation and varieties of paddy grown. In general, however, there is good evidence to show that paddy does respond to judicious manuring, whether with artificial fertilisers or organic manures like cattle manure, green manure and compost, and that economic returns can be secured thereby.

The fertilising constituents essential for increasing yields of crop on most paddy soils in Ceylon are nitrogen and phosphoric acid. In a few areas nitrogen alone, and in others phosphoric acid alone is beneficial; in the majority of the paddy areas, however, a combination of nitrogen and phosphoric acid gives best results. Where a field carries a luxuriant weed growth the nitrogen supply can be considered adequate; where weed growth is poor, both nitrogen and phosphoric acid may be lacking.

While artificial fertilisers alone are capable of increasing yields in most areas that have been under paddy for a number of years, the incorporation of some bulky organic manure along with the artificial

fertiliser, in all but the soils well supplied with nitrogen and humus, is productive of even better yields. This is especially so on light soils poor in organic matter or on heavy clay soils. These organic manures, more particularly cattle manure, should not, however, be used in excess or there may be danger of increasing the production of straw at the expense of the grain; and/or of the lodging of the crop. One ton of cattle or green manure per acre would be a suitable application when artificials are used, and up to 5 tons per acre (on the average 2 to 3 tons) when applied alone. These organic manures are best applied at the second ploughing, but the soil should be kept well moist thereafter.

Of artificial fertilisers the following are to be recommended for paddy: sulphate of ammonia, superphosphate, basic slag, ammonium phosphate (niciphos or ammophos in two grades—narrow ratio and wide ratio) and steamed bone meal. The fertiliser which has been found most generally successful on soils of varying types is ammonium phosphate, whether as niciphos or ammophos. These fertilisers are therefore recommended for paddy at the rate of  $\frac{1}{2}$  to 1 cwt. per acre depending on the nature of the soil and whether used in conjunction with organic manures. When applied alone  $\frac{3}{4}$  cwt. of the fertiliser per acre is recommended for average soils. If applied with cattle or green manure  $\frac{1}{2}$  cwt. per acre may suffice. Of the two grades of niciphos or ammophos, the narrow ratio grade (nitrogen and phosphoric acid each about 18 per cent.) should normally be used. It is cheaper than the wide ratio grade and appears to be as efficient as the latter on many soils. Where the soil is deficient in phosphoric acid but fairly well supplied with nitrogen, the wide ratio grade of ammophos (nitrogen 11 per cent., phosphoric acid 46 per cent.) or niciphos (nitrogen 14 per cent., phosphoric acid 43 per cent.) whichever is the cheaper, is recommended. In either case the fertiliser is best applied about a day before sowing or transplanting. It is essential that the soil should be well saturated with water before the application.

Where weed growth is luxuriant and additional nitrogen does not appear to be necessary, an application of  $\frac{3}{4}$  to 1 cwt. of either steamed bone meal, basic slag or ordinary superphosphate may be given. These are best applied at the final ploughing of the field.

On a very few soils, where the soil is rich in phosphoric acid, as in calcareous soils, sulphate of ammonia alone at the rate of  $\frac{3}{4}$  to 1 cwt. is likely to be beneficial. The application may be given a day or so before sowing or transplanting.

Manuring should be resorted to only after other possible improved methods of cultivation have been adopted. Transplanting is

one such method. Yield increases of over 25 per cent. can be obtained by transplanting as against broadcasting. While manuring does increase the yields of broadcast crops, the experimental evidence indicates that a larger yield increase is more likely to be obtained if the crop were transplanted. Where, however, transplanting is not feasible, as with early maturing varieties, manuring is recommended. It is advisable when no previous manuring has been done, that only a small area be treated in the first in order to determine whether the returns from manuring are economic or not.

In regard to the economics of paddy manuring, it may be stated that in general the cost of the fertiliser and its application should not exceed Rs. 7.50 per acre. If paddy is priced at Re. 1.50 per bushel, an increase of 5 bushels per acre would cover the expenditure on manuring. Generally speaking, yield increases of 20 per cent. and over equivalent to a minimum of from 6 to 8 bushels per acre, can be obtained with resultant profits. Where paddy is priced at Rs. 2.00 per bushel the returns from manuring should be correspondingly greater.

*The Tropical Agriculturist*, Vol. LXXXVIII, No. 3.

### Fertilizing of Sugarcane under Irrigation

BY

**H. H. Dodds**, *Director, S.A. Sugar Association Experiment Station*

As far as I am aware no fertilizer experiments with sugarcane under irrigation have been done, and significant results in the experimental or mathematical sense recorded, in this country. One can, therefore, discuss the fertilizing of sugarcane under irrigation in this country only in general terms and principles, based solely on experience in other countries where climatic conditions and soil requirements may be very different from ours, and results therefore, not at all specifically applicable, but which may serve to illustrate general principles.

It appears that fertilizer requirement is fundamentally based on the nature of the soil and the plant, rather than on irrigation practice. Nevertheless, since every plant has the capability of suspending operations to a greater or lesser extent during periods of drought and of regulating its growth according to water supply, it follows that the reduced size of crop that results makes lesser demand on the plant food originally available or added when compared with a crop that has suffered no such checks to its growth through lack of moisture.

One would say, therefore, that an irrigated crop requires approximately the same kinds of plant food in more or less the same proportion but in greater quantity, according to the larger crop to be expected.

This certainly seems to apply to the principal so-called "mineral" plant foods, phosphate and potash, but in the case of nitrogen it appears that the plant can profitably respond under irrigation to repeated large quantities out of proportion to the requirements and response of the unirrigated crop. Hence we find in such countries as Puerto Rico where cane is grown under irrigation or in naturally well-watered soils the application of 400 to 600 lb. per acre of a complete fertilizer containing half to two-thirds of sulphate of ammonia, and the rest superphosphate and potash salts, six or eight weeks after planting (no fertilizer is applied earlier than this), followed by a further 400 lb. or 600 lb. of sulphate of ammonia six to ten weeks later, and often a further similar application a few weeks later.

In Java, sugarcane is almost exclusively grown under irrigation. Here it is rather exceptional to apply any phosphate or potassic fertilizer, the reason apparently being that the irrigation water is charged with volcanic silt washed down from the hills. This silt is sufficiently rich in both phosphates and potash to restore the quantities of these elements taken out of the soil by the cane-crop or even to accumulate them.

Sulphate of ammonia is used very largely, however, and the optimum quantity for each district and each type of soil has been worked out as the result of hundreds of field experiments. (Until recently the Javan Experiment Station maintained for many years as many as 15 local field officers in different districts, one of whose duties was the carrying out of co-operative experiments of this kind in their area.)

The best average quantity of sulphate of ammonia to apply is about 400 lb. per acre per annual crop, and this is the average quantity that has in fact been used commercially through the Industry in recent years.

It has also been found experimentally that this should normally be applied in two or three doses, the first dose to be applied not until at least a fortnight after planting the cane.

Hawaii is another highly progressive sugar-growing country where most of the cane is grown under irrigation and where a very large amount of study has been given to fertilizer requirements. Here also practice is based on the results of an enormous number of very comprehensive field experiments.

Phosphatic fertilizer is used wherever field experiments have indicated a response to phosphorus, or even where no positive response can yet be demonstrated, but where indications are that the

reserves of phosphorus in the soil are approaching depletion. In practice, therefore, phosphates are seldom entirely omitted from a fertilizer programme.

Superphosphate, or in some instances ammonium phosphate, is considered the best form in which to apply phosphorus, and the quantities that are frequently applied seem very high according to our standards, up to 260 lb. per acre of  $P_2O_5$ , corresponding to 1300 lb. per acre of superphosphate, 20%. Sometimes in addition to regular applications of superphosphate, 500 lb. 1000 lb. of raw rock phosphate may be added to build up reserves of phosphorus in the soil.

Phosphates are applied in one to four applications, the first being made at any interval from time of planting to three months thereafter, and the last not later than five months after planting. The same times of applications are used for potassic fertilizers.

Nearly all Hawaiian soils have large reserves of potash but if there are indications from field experiment or chemical analysis that available potash may be lacking, it is applied.

The quantities used range up to 375 lb. of  $K_2O$ , equivalent to 625 lb. of the chloride (muriate) of potash; but seldom less than 75 lb. of  $K_2O$ , equivalent to 125 lb. of the chloride are applied, if potassic fertilizer is used at all.

Potash is used almost entirely in the form of the chloride, except for a little nitrate.

Nitrogen is used in quantities varying from 125 lb. to 300 lb. per acre, equivalent to 600 lb. to 1500 lb. of sulphate of ammonia. The first application is made at any time within three months of time planting, according to circumstances, and the last not later than 14 months after planting and not later than 8 months before harvesting, usually much earlier than this.

Nitrogen is applied in from one to six applications ranging from 100 lb. to 880 lb. of sulphate of ammonia in one application.

Sulphate of ammonia is the form mainly used, and a certain amount of ammonium phosphates. Relatively little nitrate of soda or of potash is used nowadays, or organic nitrogen.

The upshot of all this is that fertilizer is used in Hawaii in far greater quantities than is considered necessary in this country and that far greater average yields of cane are attained. This application is the result of a carefully planned policy on each estate based on local field experiment and soil survey and analysis.

In conclusion one may repeat that the indications are that irrigated sugarcane needs the same kind of fertilizers as unirrigated, with the possible exception of a greater proportion of top-dressings of sulphate of ammonia, but in greater quantity.

Although little or no practical information is forthcoming in this country, it may be urged that fertilizer experiments have been done in the Zululand alluvial soils where there is normally an ample moisture supply, and indicated that there was no apparent response to fertilizer either in the first or second crop.

This certainly is the case, but to my mind by no means the last word has been said on this, and that all we can say at present is that a profitable method of applying fertilizer on the Umfolozi or Umhlatuzi flats has not yet been indicated.

The next logical step would appear to be to try the effect of relatively heavy top-dressings of fertilizer, especially sulphate of ammonia, under these conditions.

*The South African Sugar Journal*, Vol. XXI, No. 2.

### Indian Agricultural Indebtedness

Agricultural indebtedness forms, as is well known, one of the most serious and most urgent problems in India. It has been said of the Indian peasants that most of them are born, live and die indebted and bequeath their debts to their children.

The Indian Central Banking Enquiry Committee estimated the total indebtedness in 1929 in British India alone at 900 crores\* of rupees, and this figure has since greatly increased owing to the fall in prices which for certain products has amounted to about 50 per cent.

It is calculated that if no repayment of capital took place between 1929 and 1932, the actual volume of debts must at present amount to about 1,800 crores, and, if all the interest were in arrears, to 2,200 crores. The total production of the principal commodities decreased, at the same time, from 1,018 crores in 1928-29 to 536 crores in 1931-32. Thus while incomes considerably declined, the debt very largely increased.

While the volume of agricultural indebtedness forms a problem in itself, the rate of interest at which most of the debts have been contracted forms a second, and equally thorny problem. In certain districts in the Bombay Presidency, 12 per cent. is the ordinary rate of interest and the village money-lenders charge from 18 to 24 per cent., but in Bihar and Orissa, Sind and Assam, the rate varies between 25 and 50 per cent. and even in the United Provinces it runs from 18 to 37 per cent. It is true that the land-owners in

\* 1 crore = 100 lakhs; 1 lakh = 100,000.

most of the provinces can obtain loans on first mortgage at between 9 and 12 per cent. interest, but the small land-owners must often pay higher rates and, as happens in the case of tenant-farmers and labourers who cannot offer adequate security, the rates applied may sometimes reach between 150 and 300 per cent. The interest on loans of cereals is never less than 25 per cent. and, in certain regions, it amounts to between 50 and 100 per cent.

The original cause of indebtedness lies in the inadequacy of the receipts, which is due to the extreme smallness of the farms, to the inefficient methods of production and sale, to the frequent failure of the crops and to the mortality of live-stock. The agricultural population of India is increasing, but the lands available for cultivation are limited. The proportion of farmers in the total population increased from 61 per cent., in 1891 to 66 per cent. in 1901 and to 73 per cent. in 1921, and the slight decrease of 2 per cent. registered by the Census of 1931 is of doubtful importance. The total cultivated area is 228,800,000 acres. This represents barely an acre per head of the total agricultural population, and about  $4\frac{1}{2}$  acres, on the average, per farmer's family. In the course of the decade between the Census of 1921 and that of 1931, the sown area only rose from 224,900,000 acres to 228,800,000 acres, an increase of less than 2 per cent. while the population rose from 319,000,000 to about 353,000,000 an increase of more than 10 per cent. On the other hand, the yield per acre, for the important crops, such as rice and wheat, remained practically stationary for 20 years, whilst for other crops, such as cotton, for example, it only increased slightly.

A characteristic of Indian Indebtedness is that it results mainly from unproductive expenditure, that is, from expenditure for purposes other than agricultural. Thus in the United Provinces 60 per cent. of the outstanding debts were, according to the Provincial Banking Committee, contracted for such purposes as marriages and other social ceremonies, for the maintenance of the family and for the payment of taxes.

One of the most deplorable results of the indebtedness is the decline of the class of independent peasants. It is estimated that, between 1921 and 1931, the number of farm servants per thousand ordinary farmers rose from 291 to 407, which represents a considerable increase in the landless population.

Another consequence of the debts is the frequent transfer of lands from one holder to another. It is calculated that in the space of thirty years, each parcel of land in a village changes hands at least once.

During recent years the problem in question has been specially studied in India by the Royal Commission on Agriculture in India

(1928), and, from 1929 onwards, by the Indian Central Banking Enquiry Committee, which made known its results in 1931. Since then the question has been constantly under study, and several measures have been taken or contemplated to relieve the indebtedness.

The Government of India in April 1934, convened at Delhi a conference of the provincial governments to decide upon a common programme of action in regard to the difficulties caused by the fall in prices and the decline in the demand for raw materials and, in particular, to study the effects of these facts on the condition of the farmers.

The first question considered by the Conference was that of agricultural indebtedness. The possibility of developing mortgage credit banks was discussed, amongst other matters, as also were the functions of the agricultural credit department of the new Central Reserve Bank that it was proposed to establish in India.

In connection with the Debt Conciliation Bill, presented to the Legislative Council of Madras towards the end of 1934, the Board of Revenue (Land Revenue and Settlement) ordered an enquiry to be made into the problem of agricultural indebtedness in the Presidency. This enquiry, which was completed in July 1935, showed for two typical villages of each of the districts of Madras, that between 1931 and 1934, 23,932 acres had changed owners, largely as a result of sales and mortgages. Of this figure, 4,772 acres, or about 20 per cent. were transferred to persons who were not agriculturists. On the basis of this observation, it was calculated that, for the whole Presidency, the area transferred from one owner to another would be approximately 10,351,000 acres, that a very large part has passed to large absentee owners, for the most part money-lenders. It results, therefore, that many owners of small and medium-sized holdings have been dispossessed and remained without land and in poverty because of foreclosures for debt.

As regards the rates of interest, for mortgages without possession they ordinarily vary between 9 and 12 per cent. but there are also cases in which the interest varies between 6 and 9 per cent. and others in which it amounts to more than 12 per cent. rising to 18 and even to 24 per cent. Interest lower than 6 per cent. or higher than 24 per cent. is rarely met with. It must be noted that we are here speaking of ordinary rates of interest. There are much higher rates of interest, but these have so to speak a penal character and are due to the fact that the borrowers rarely repay their debts at the due date.

As to the amount and distribution of agricultural indebtedness, the enquiry studied 141 selected villages in the Presidency. From data thus collected referring to the year 1935, it appears that the total

number of indebted persons was 74,892, including 48,358 land-owners, 16,039 tenant-farmers, and 20,620 agricultural labourers and that the aggregate indebtedness amounted to 1,78,85,666 rupees. The indebtedness per head of the population may be calculated at 38 rupees, and the indebtedness per cultivated acre 63 rupees. On the basis of these figures, it has been calculated that the total agricultural debt in 1935 for the whole Presidency was about 200 crores of rupees.

In 1932 the Government of the United Provinces—as had been done in 1930 in the Province of Bihar and Orissa—instructed a committee to study the problem of agricultural debts and to present recommendations. The report of this committee showed that the total unpaid debts had considerably increased and that interest was only being paid to a very small extent. The committee recommended that conciliation committees should be formed to bring about arrangements between creditors and debtors. Subsequently three bills, the Agricultural Relief Bill, the Reduction of Interest Bill, and the Usurious Loans Bill, were submitted to the Legislative Assembly.

The Government of the Central Provinces adopted in 1933 the Debt Conciliation Act, which set conciliation committees. Under this law, conciliation must be voluntary, but the committee can compel the creditors to draw up and to present detailed accounts of their claims, accompanied by the documents establishing them; the creditors who do not comply with this demand of the commission lose all their rights. Moreover, those of the creditors who accept an arrangement are given, in the carrying out of the judgments they obtain, priority over other creditors. Those who, on the other hand, refuse to agree to any adjustment, cannot, if they bring the case into court, recover the costs of the action, and they can only be awarded interest at the rate of 6 per cent. on the principal, the amount of which will be determined by the court. The Government has, moreover, amended the Usurious Loans Act, the provisions and procedure of which have been revised so as to enable the courts to examine the previous transactions of the money-lenders and to declare excessive and fraudulent, any interest exceeding 12 per cent. on secured credits and 18 per cent. on credits not secured. It was ascertained that interest ranging from 15 to 75 per cent. was commonly charged. On the other hand, compound interest will no longer be allowed. Lastly, the Government submitted to the Legislative Assembly a bill, the Money-Lenders' Bill, which lays down the manner in which the money-lenders must keep their books and provides that they must present, every year, a detailed account to their debtors. The law also contains a rule to the effect that the accumulated interest must never exceed the principal, however long the debt may have been owing.

In the Punjab, too, the Government has submitted to the Legislative Assembly various bills on the problem of debts.

The plan for agricultural indebtedness applied, from 1930 to 1934 in the Native State of Bhavnagar, has roused much interest in India. We will here describe it:

In January 1922, a certain number of *kheduts*\* complained to the authorities of the desperate economic condition in which they found themselves, attributing this condition to the excessive interest and to the commissions of every kind charged by the local money-lenders (*Sowcars*). The sums due by the indebted *kheduts* sometimes reached, according to an official enquiry, 15 to 20 times the amounts of their annual income. The *khedut*, even if perfectly solvent, could not obtain loans otherwise than by the system of *savaya*. Under this system, when a peasant borrowed, for example, at the season of sowing or of hoeing, 100 rupees, 25 rupees was added to this sum by way of commission and a note of hand was drawn up for 125 rupees, payable within a period of four to eight months, that is to say, after the harvest. But these terms were granted only to solvent *kheduts*. Others had to undertake to repay the loan at a date agreed upon, not in cash, but in kind, the quantity of products to be delivered (of cotton, for example) being valued below the market price and below the price that could be obtained for it at the time of the harvest.

A form of loan, known as *alak*, consisted in introducing into the agreement a clause according to which, in default of payment of the sum due at the date agreed upon, the borrower bound himself to settle the debt in kind. According to the report of the enquiry in question, the *sowcar* succeeded in certain cases, by means of the *alak* in obtaining in six months, five or six times the initial amount of the loan.

In the system known as *kadhara*, the equivalent of the seeds lent for sowing must be returned after the harvest with an addition of 50 to 70 per cent.

The plan adopted by the Government of Bhavnagar involves a widespread action for liquidating the debts of the peasants. To assure the success of this action, the Government counted on the voluntary collaboration of the *sowcars* and *kheduts*. It invited the *kheduts* to declare their debts and the *sowcars* to declare their claims.

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\* A *khedut* is a cultivator domiciled in the State who, either single handed, or with the aid of servants, derives his income, wholly or in part, as a registered tenant or sub-tenant of a holding of which a part at least belongs to the State.

The declarations were carefully checked and an adjustment was made on the following basis:

(a) The sum that had to be paid by an individual debtor must not exceed an amount equivalent to three times the annual dues paid by the debtor to the State;

(b) The total amount of the sums to be paid by a *tappa* (group of neighbouring villages) must not exceed a quarter of the total amount of the unpaid debts of the peasants of this *tappa*.

The plan was financed by the Government, which advanced to each debtor the sums he required to free himself; these advances had to be repaid to the State by successive instalments, by means of an increase of 4 per cent. on the amount of the annual dues. The debtor was, however, allowed to pay off the amount in a single payment or to pay instalments larger than those that had been fixed.

The carrying out of the plan was entrusted to Debt Conciliation Committees nominated by the Government consisting of representatives of the Departments of Finance and of Justice. These committees began their work in April 1930 and by March 1934 their action had extended over the whole country and all the debts of the *kheduts* had been extinguished. The total debts, of which the nominal amount, according to the books of the money-lenders, was 8,638,874 rupees, were settled by payments totalling 2,059,473 rupees.

The total amount that was really due according to the Government, was 4,511,183 rupees, which means that more than half of the nominal amount of these debts was fictitious and that it had only been arrived at by means of irregularities, frauds or excessive usury on the part of the money-lenders.

The *kheduts* will be protected in future against the exactions of the *sowcars* by the *Kheduts* Protection Act, which gives the courts the power of examining in detail transactions concluded between the money-lender and the debtor, from the origin of the debt, and to determine the capital really due. The court can also determine the amount of the sums already paid, as well as fix the interest, which must always be simple and not compound interest, at a rate not exceeding 12 per cent. per annum. No contract will be valid, in the eyes of the law, if the rate of interest agreed upon exceeds this maximum.

In other Native States also, much importance has been attached to this question. In the State of Mysore, the Government has instructed a commission to draw up plans for the formation of debt conciliation committees, for the regulation of the activity of the money-lenders and for the creation of other possibilities of credit. In the State of Cochin, the Government has decided to reduce the debts and to bring down the rates of interest to 6 or to 7½ per cent. on secured

credits and to 9 per cent. on credits not secured. In the State of Hyderabad, the Government proposes to take steps to relieve indebtedness and to prevent usury. In the State of Revah, measures have been taken to prevent the debtors from being compelled to sell their land for the fulfilment of a pledge.

*International Review of Agriculture*, Vol. XXVIII, No. 4.

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## **The Cashew Nut Industry of South India**

BY

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The cashew tree is a native of Central and South America as well as of the West Indies. It was introduced into India by the Portuguese for the main purpose of checking erosion on the west coast of the Peninsula and on the sandy dunes of the east coast. It now grows wild, chiefly along the west coast as far as Bombay but also in parts of the east coast such as the Guntur, Godavari and Vizagapatam districts. The tree is capable of thriving under widely different conditions of soil and climate. In South Kanara, it grows on red laterite soils under a rainfall of about 150 inches per annum though over 90 per cent. of this is distributed during the south-west monsoon from May–October while on the east coast, it is found on sandy tracts with a rainfall of less than about 40 inches per annum.

In all parts of South Kanara which is the largest producing and exporting district of kernels in India the tree grows wild. Along the coast, it occurs mixed with other shrubs on the hill slopes and develops a somewhat spreading habit owing to the poor soil and exposed position. But on a sandy soil and in a sheltered situation it grows more erect and does best.

### **PRODUCTS OF THE CASHEW**

There are several economic products of the cashew but with the exception of the kernels these have not yet been made commercially successful. The present importance of the cashew in India lies in the value of its kernels for which there is a large market in New York and to a lesser extent in London where these are used in confectionery. It is reported that owing to the bland taste of these kernels and their similarity to almonds and walnuts they have gained much popularity. An industry for the export of the kernels has rapidly developed along several centres of the west coast of India, of which Mangalore is the chief. In 1924, the export of kernels from India amounted to about

300,000 lb. while in 1934 it totalled 9 million pounds and from South Kanara alone  $6\frac{3}{4}$  million pounds.

There are about six cashew factories located in Mangalore, employing about 15,000 workers, mostly women, for the extraction and export of the kernels. The fresh nuts are purchased from the ryots but as the supplies from South Kanara are insufficient for the factories in Mangalore, nuts are also obtained from Goa, Malabar, Cochin, Travancore and even Portuguese East Africa. The total production of nuts from South Canara is about 120,000 bags of 130 lb. each but from Malabar about 30,000 bags and from East Africa 140,000 bags are obtained for extraction of the kernels in the factories of South Kanara.

On the west coast, the nuts are available from February–April and even up to the end of May each year from Goa and Malvan districts in the Bombay Presidency. The East African cashews have a different season and the nuts are imported from October–December thus enabling the factories to be kept engaged throughout the year. In Ceylon, the cashew nut season is usually from April–July.

The kernel is also esteemed in India and there is a small market as well for raw kernels and the “brokens” extracted from the roasted nuts as these are unsalable in the overseas market. The kernels from tender nuts are used in South India for curries, *payasams* and *bhaju*. They are usually sold at Re. 0–1–6 per 100 kernels. The kernels of mature nuts are sold only after roasting and are used in the preparation of different Indian sweets. They are also eaten with jaggery and coconut, being fried in oil or ghee and mixed with Bengal gram powder. Reference to the other products of the cashew may be made to a note on this subject in *The Tropical Agriculturist* for July 1936.

#### VARIETIES

There are several varieties of cashew showing differences in the colour of the fruit (red, yellow or intermediate), the shape of the fruit, the size and shape of the nut, the size and shape of the kernels, the season of bearing (early, main or late) and the tendency to shedding of the flowers. Work on the selection of suitable varieties for yield, season and quality of the kernel has only just commenced on some of the agricultural research stations on the west coast.

Until recently, the yield has not been regarded as an important factor because the tree was allowed to grow without any attention but with the present importance attached to the cashew tree on account of the value of its kernels an interest is being shown in the cultivation of this crop and new areas are being planted up. With the increased attention now being paid to this crop growers are becoming concerned with the question of yield.

Quality of the kernel is of great importance and determines the price and the demand. Good quality kernels should be white, bold and hard. Sweetness is desirable though it alone does not commend a higher price. The best quality kernels come from Travancore while those from North Kanara are the worst being too hard and fibrous. The East African kernels are smaller but give a higher percentage of kernels from the nuts. This is an important consideration with the factories which pay a higher price for varieties which give this higher percentage. While the South Kanara nuts result in about 28 per cent. of kernels on shelling, the East African nuts give about 30 per cent.

The nuts show considerable variation in size but in the case of the large nuts, the kernels are not necessarily large in comparison with those from medium size nuts. Selection of varieties for yield and quality should not, therefore, be based on size of nuts without considering the size of the kernel. Small, round nuts have generally well-filled kernels which are termed bold in the trade. The nuts on the west coast vary from about 60 to 150 per pound while in Ceylon the range of variation is from about 30 to 125 nuts per pound. The East African nuts are smaller than the west coast nuts of India. Varieties also differ in the degree of whiteness and hardness of the kernels.

At present, on the west coast the nuts are available during February–April but there are varieties which bear in January and even later in the season during May–June. If early or late bearing varieties can also be produced better prices will be realised as the factories will then have their supplies spread over a greater part of the year.

Premature shedding of the flowers is common in the cashew and usually only a small proportion of the flowers produced develops into fruits. There are varieties which show a comparatively small percentage of shedding. The setting of the flowers is controlled by light and humidity and it is well known that in cloudy weather setting of the flowers is poor.

#### FIELD CULTIVATION

(1) *Planting*.—In South Kanara, the ryots generally scrape the soil in the middle of some bush growing on the hill slopes and plant after the first few rains two or three nuts so that after germination the fleshy cotyledons or seed leaves are hid from the view of the cowboys who devour them if they are discovered. By planting the nuts deep—about 5 inches in the soil—the cotyledons remain below the surface and the seedlings develop undisturbed. The most vigorous seedling is then retained and the others removed but the percentage of seedlings

that subsequently develops is small owing to the absence of sufficient care and attention in raising these plants.

Nurseries are not usually sown as the tap root becomes easily damaged when the seedlings are removed from the beds. They do not stand transplanting well. But in other parts of the west coast nurseries are opened and in the course of a week to ten days the seedlings are transferred to baskets which are placed in pits filled with good soil. It is the custom in some parts of Ceylon as at Mannar to place the nuts in palmyra baskets and after about a month the seedlings with the baskets intact are planted out and good results are obtained.

The plants are usually spaced at about 30 to 40 feet apart but closer spacing is advisable in the earlier stage of growth and if the plants are set at about 20 feet apart they can later be thinned out to 40 feet apart. In more sheltered areas the planting may be somewhat closer.

(2) *Intercultivation*.—No attention was formerly paid to the cultivation of the cashew but some ryots hoe their land every year towards the close of the south-west monsoon. During the months of July and August when there are heavy rains on the west coast of India any cultivation is inadvisable owing to soil erosion which results thereby.

Manuring is not practised though the tree responds readily to it, not only in an increased yield but also in earlier bearing.

(3) *Harvesting*.—The fruits with the nuts attached are harvested by means of a long stick with a curved knife at its end. This is usually done before the fruits are fully mature, because of the anxiety of the ryots to sell their nuts as early as possible. Tender nuts sometimes are removed and sold in the local market at  $1\frac{1}{2}$  to 2 annas per 100. The disadvantage in harvesting the fruits off the trees lies in the removal of the immature fruits and nuts as well as of the flowers. In East Africa, the nuts are allowed to drop and are picked off the ground.

(4) *Yields*.—The cashew tree is quick growing and is capable of bearing within about 18 months, though it is not until the tree reaches its fifth or sixth year that it commences to give economic yields. It comes into full bearing by about its tenth year.

In South Kanara, the flowers appear from December to February and the nuts are ready for picking between February and April. The average yield is reported to be about 20 lb. nuts per tree but this would be much more if not for the heavy loss of flowers and tender nuts occasioned during harvesting. There are, however, some trees which give as much as 100 lb. per tree.

On shelling, about 25–30 per cent. of kernels are obtained and these after removal of the thin skin covering them yield about 80–90

per cent. of peeled kernels. Shelling usually results in about 75–89 per cent. of wholes and 11–26 per cent. of broken. In the extraction of the pericarp oil about  $1\frac{1}{2}$  modas ( $27\frac{1}{2}$  lb.) of nuts give about 2 bottles of oil.

#### (a) Preparation of the Kernels for Export

For the overseas market, the kernels are extracted by first roasting the nuts. They are then shelled, peeled, graded and packed for export. No machinery is used in the extraction of the kernels, the whole process being quite simple. Roasting is carried out in open pans, about 6 lb. nuts being placed at a time in each pan. They are kept for about one minute, stirring continuously to prevent charring. About three bags of 140 lb.\* nuts each can be roasted per hour at a cost of six annas.

Shelling is performed by hand labour, mostly by women and about 30–50 lb. of nuts can be shelled a day by a woman. The cost of shelling is about 4 pies per lb. of shelled kernels. For roasting and shelling a bag of nuts the cost is about Re. 1.

Peeling of the thin pink seed coat is carried out after oven drying and this is again done by women who are paid in contract at the rate of 4 pies per lb. for wholes and 2 pies per lb. for broken. About 12–16 lb. of wholes and 10 lb. of broken can be peeled a day by a woman.

Further details on the curing processes are given in a note which appeared in *The Tropical Agriculturist* and referred to above.

#### (b) Preparation of the Fresh Kernels

This process is only carried out in small factories as at Lasaragad for the sale of fresh kernels in India. As soon as the nuts are purchased from the ryots they are spread out in the sun for about four days. They are then stored in bags for use as required.

Before shelling, the nuts are again kept in the sun and shelled while warm. The kernels are sold with the seed coat. About 14–21 pounds of nuts can be shelled by a woman at a cost of Re. 0–2–3.

*Prices.*—The prices paid by the factories for the nuts are liable to a certain amount of fluctuation. A bag of 130 pounds of the best Travancore and Goa nuts as also for the East African nuts is about Rs. 9, *i.e.*, nearly 7 cts. per pound. South Kanara nuts fetch about Rs. 8–8–0 per bag or about  $6\frac{1}{2}$  cts. per pound.

The kernels sell locally at about 5 annas for wholes and about 3 annas per pound for broken.

A bottle of pericarp oil fetches about  $1\frac{1}{2}$  annas in Mangalore.

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\* A bag contains 130 lbs. of nuts but for roasting and shelling a bag of 140 lbs. of nuts is used.

*Conclusion.*—The cashew tree is capable of growing without any attention under widely different conditions of soil and rainfall. In South Kanara, it thrives on a poor laterite soil and a rainfall of about 150 inches per annum with a marked dry season from November to April while on the east coast of Madras Presidency it is found on sandy soils with a rainfall of less than about 40 inches per annum. In Ceylon, too, the tree flourishes under varying soil, both on laterite and white quartz sand, under a rainfall of about 80 inches distributed during two monsoons, while near Mannar it grows on a coastal sand with a north-east monsoon during which most of the rainfall of about 40 inches is received. Near Batticaloa it is also found on sandy soils with a rainfall of about 60 inches the greater portion of which is distributed during the north-east monsoon.

The tree is thus able to grow on the poorest soil unsuited to most other crops and withstands drought well. It has come to be regarded as a waste land crop and is, therefore, one which can well be extended in most parts of the dry zone and may solve the problem for a perennial crop which can thrive in the dry zone, without irrigation.

The present importance of the cashew tree lies in its kernels for which there is a large demand in the United States of America and in Europe where about 10 million pounds are being annually purchased at present though there is demand for greater quantities. But the Indian crop is insufficient to meet this demand and the west coast factories have to resort to the importation of African nuts and are even willing to purchase whatever quantities Ceylon can supply.

In Ceylon, cashew nuts of good quality are produced but the kernels are not subject to the same roasting process as in India. Roasted as well as fresh kernels are, however, produced and sold locally. The trade is in the hands of small dealers and the nuts find a ready sale. With the present output the prices realised are somewhat better than those prevailing in India but with an increase in the extent under cultivation the local markets are not capable of absorbing much more than at present.

If Ceylon can participate in an export trade it should prove profitable but the quantities produced must be greatly increased for working even a single factory. As the crop requires the minimum of care and attention the cost of production should be low in comparison with other crops. The extraction of the kernels and the grading and packing of these for export cannot be undertaken, as at present, as a cottage industry for great care is needed in the standardisation of this product and in ensuring its arrival overseas, free from insect attack.

It is essential if Ceylon is to enter the export trade in this commodity that a factory with equipment in packing the kernels in hermetically sealed and standard cases be established. But in the meantime it should prove profitable to export the surplus nuts from Ceylon to factories on the west coast of India as in the case of East Africa.

The possibilities of developing a cashew nut industry in Ceylon are, therefore, considerable and deserve full attention.

*The Tropical Agriculturist*, Vol. LXXXVII, No. 3.

### Recent Work in Plant Breeding

BY

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For some eight thousand years man has been engaged in the breeding of plants for his own use, and during these long centuries of time there has been a steady improvement of all the plants which provide him with material for food, clothing and ornament. Up to thirty-five years ago this improvement was for the most part haphazard and accidental; though in fact intelligent selection of the best and most useful varieties was constantly practised, and any new improvements unexpectedly arising were carefully preserved. Actually the progress achieved by these non-scientific but commonsense methods was extraordinarily good, but owing to a lack of knowledge of the laws of heredity it was of necessity extremely slow and often wasteful in effort and outlay.

In 1900 the finding of Mendel's long-lost paper disclosing his discovery of the fundamental laws of heredity caused a complete revolution in breeding. To their credit plant-breeders were quick to grasp the importance of the new facts in helping them to a more speedy and a surer solution of their problems. In all cultivated plants new work was enthusiastically carried through, old varieties were tested and purified and new varieties were raised which contained a preponderance of desirable qualities. The further discovery that all heritable characters, whether structural or functional, were due to the actions and reactions of the minute living molecules known as genes, situated in the chromosome threads of the nucleus of each cell in every plant and animal (including man), was a still greater cause of progress. It was immediately realized that the best results in breeding could only be obtained by an intensive study of the chromosomes and genes of any plant which was being used. This study revealed many startling facts, and provided a complete explanation of some hitherto

quite inexplicable difficulties. It is safe to say that the union of the two new sciences of Cytology and Genetics into one was one of the greatest revolutions ever brought about in biological science and is bound to have the greatest possible influence on the future of man.

After thirty years of concentrated experiments by a great number of research workers with millions of plants and animals in the numerous laboratories and research stations which had sprung up all over the world, it was realized that in many cases the limit of improvement had been reached. The existing varieties had been bred to such an extent that their possibilities were more or less exhausted, their desirable genes had all been utilised and all the most desirable combinations had already been attained, though in many cases the ideal had not been fulfilled. Only one thing could give further progress—the introduction of new genes and new methods of combining them with the old genes.

The discovery that new mutations could be produced by X-raying gave a new stimulus to the work. Unfortunately as in all natural mutations, the great majority of X-ray mutations are pathological or lethal, so that although their incidence is enormously increased the production of new forms of real value by this means involves considerable labour in testing large progenies. Fortunately a new and extremely profitable method arose in the hybridization of widely distinct species and even genera which, by their combination, brought together entirely new gene-complexes of a highly desirable kind. Hitherto the union of different species had brought about little success owing to the sterility of the hybrids. The discovery that a duplication of the entire chromosome set of the hybrid either in the germ cells or in the body cells (Hurst, 1933, 1935) produced fertile germ-cells and progeny and created new species and genera, gave new hope to this branch of breeding which has proved to be amply justified. In this connection the use of X-rays is of great value, for one of the most useful results of this treatment is the duplication of chromosome sets. In an ordinary species this is important, although not of vital importance, since it only increases the size of the individual without producing any other desirable genic changes, but in these specific or generic hybrids it is of the utmost value, for it converts a sterile hybrid into a fertile and pure-breeding new species or genus combining the qualities of the two parent species, and containing a new complex of genes which often in their reactions together give rise to new qualities. Above all the new forms possess greater potentialities for mutation in the greater number of genes, and hence afford more hope for the production of new varieties.

Here we come to the real essence of modern plant-breeding. Once the possibilities of interspecific and intergeneric breeding were

realized the introduction of new genes became an all-absorbing problem. The great work of the modern breeder is the search for new genes, especially, those which give resistance to the numerous and devastating diseases which attack crops in every country. Fortunately, it has been discovered that in most genera there are many wild-growing species which are immune to the diseases which attack cultivated plants, and by using these species it is hoped to be able to produce disease-resistant plants which will still contain all the desirable points of our best cultivated varieties together with the addition of other good characters which are not yet present.

Under their able leader Dr. N. I. Vavilov, the Russian plant-breeders have been in the forefront of this new phase of breeding. Expeditions have been sent out to every country in the world to collect all the possible species allied to the plants which constitute our present crops, and also to discover new sources of the various commercial commodities, such as fibres, oils, rubber, etc. In addition to the wild-growing species there are many ancient species and varieties still in cultivation in remote and outlying districts which contain valuable qualities, especially in their adaptation to peculiar and exacting environments. One of the great problems of modern plant-breeding, besides that of disease resistance, is the production of varieties which will give a full yield under adverse conditions. In a country such as Russia, and within our own Empire (under such diverse conditions as exist in Australia or Canada), there is a great need for new varieties and new types of crops fitted to each particular type of locality. It is useless to expect a high-yielding, disease-resistant plant fitted to normal conditions to function adequately in districts subject to drought or to extreme cold; such districts must have their own varieties specially bred for them. For this purpose the old-type crops of the isolated communities are ideal, for they have, through countless generations of natural selection, become adapted to their environment, which in many cases is of a highly specialized character since they are usually found in out-of-the-way mountain districts or under steppe or desert conditions. In these districts there is a wealth of new genes to be found in every kind of cultivated plant fitted to all possible conditions.

The experimental stations throughout the world are making exhaustive collections of the likely wild-growing species and of the locally cultivated crops, and from the new gene combinations arising from their hybridization with our existing crops great hopes are entertained.

*Cotton.*—In cottons work has been proceeding steadily all over the world. In attempts to produce cottons suitable for their diverse environmental conditions the Russians have put in an immense amount

of work in studying the genes and chromosomes of varieties and species, and have carried through numbers of hybridizations. At Tashkent, a study was made of ginning percentages by investigating the number and weight of the fibres and weight of seed, and it was found that there was a wide deviation in this respect between different cottons. The number of fibres per seed in seven varieties of American cotton varied from 7.8 to 14.7 thousand, while the weight of a thousand fibres varied from 4.4 mg. to 7.6 mg., and the seed weight from 97.0 to 167.2 mg. In *G. herbaceum* the number of fibres per seed varied from 3.6 to 9.2 thousand, the weight of a thousand fibres from 3.4 mg. to 5.8 mg., and the seed weight from 69.7 mg. to 111.8 mg. Crosses have been made in which it is hoped to combine the higher number of fibres with the heavier weight, and in the second generation of a cross between two lines of *G. herbaceum* some plants arose with the desired combination and showed a ginning percentage of from 7 to 13 per cent. higher than the better parent. In the fourth generation a true breeding line was obtained in which the percentage was 8 per cent. higher than the better parent.

The type of boll in *G. herbaceum* is very variable, but the closed boll proved to be a simple mendelian recessive to the open or semi-open boll, both of which are undesirable in mechanical harvesting. Size of boll was found to be dependent on a number of genes in American cottons, and it was necessary to grow some thousands of  $F_2$  seedlings to obtain the desired types. By crossing with early maturing forms it was also found possible to unite high yield with early maturity. Many other points were studied, and it is pointed out that since a large number of genes are involved in these cottons it is wiser to limit the parental combinations as much as possible in producing new varieties by hybridization, and to grow the largest possible number of progeny. Back-crossing is also useful for reducing the number of segregating types in later generations.

The Transcaucasian Cotton Research Institute have issued a *bulletin* describing the progress made in the acclimatization of Egyptian cottons; descriptions, illustrations and lint qualities of selected new lines are given. The varieties have been divided into six groups based on their maturity periods. Another publication from Moscow gives the spinning qualities of a number of the best improved varieties grown in the U.S.S.R. Varieties of the Pima type of Lower Egyptian cottons have been grown under varying conditions for comparison. Upper Egyptian types, including Ashmouni and allied varieties, Uplands and strains with medium staple, have also been tested. It has been found that by means of transplantation it is possible to grow high-quality Egyptian varieties in the region of

Tashkent, and some selections of Pima can be spun to 120 counts. Longstapled Uplands, however, are superior in yield, and are as good as the Egyptians for spinning 50's and 60's.

The experiments in vernalization of cotton were attended with much success, not only in producing a higher yield under normal conditions but also in several cases, in increasing lint length. The seed is moistened and then kept at a temperature of 25°C. to 30°C. for varying periods. It was found that the best results were obtained after 10 to 15 days' treatment for Navrotskii, 15 to 20 days for Acala 8517, and 15 days for the Egyptians; longer periods caused depression of germination and shorter periods had no effect. The chief effect of optimum treatment seems to be a more rapid completion of the various phases of development rather than any particular acceleration of their inception. All the varieties vernalized germinated from 2 to 3 days earlier than the controls, but later stages showed considerable variation. In the American cottons treatment produced a tendency to higher ginning percentage and length of lint, but in the Egyptians the ginning percentage was increased while the lint length was slightly decreased. The flowering period was usually from 3 to 4 days earlier, but in Navrotskii it was as much as 13 days, and in Ashmouni 9. The differences in maturity were often greater, varying from 4 to 15 days earlier. In all cases, the plants treated in the Russian experiments showed an improvement over the controls, and it is probable that this method may be of much value in growing crops in those regions not naturally fitted for them. Certain cases of failure are attributed to imperfection of technique rather than to any deficiency in the treatment, and different varieties gave widely different reactions; in some cases there were even differences within the varieties themselves. It is pointed out that greater knowledge is needed before the best results can be expected. The effect of the treatment was considerably greater in 1933 (which was a very bad season for cotton-growing in the new regions) than in 1934, when the natural conditions were more favourable to normal growth. Vernalized sowings were made on a large scale on collective farms in 1932, 1933 and 1934, with an increase from 600 ha.\* to 3,000 ha. under cultivation in the three years. The average yield increase was from 0.3 to 2.5 centner† per ha. but on one farm the yield increase in the treated crops was four times that of the untreated.

At Tashkent experiments were also made on the photoperiodism (adaptation to length of light-day) of the cotton plant, subjecting different varieties to daily illumination amounting to 6, 9 and 12 hours against the average of 14 hours of the controls growing under

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\* Hectare=2.4 acres.

† Approximately 1 cwt.

normal conditions. Observations showed that cotton is essentially a short-day plant, which complicates its successful growth in long-day regions, since a reduction of illumination causes early maturity. Different varieties, however, show different hereditary reactions corresponding to the position of their original environment with regard to the equator, those from equatorial regions needing the least light and this effect becoming less and less as their place of origin is further removed from the equator. The general effect of the shortened illumination is the production of sympodial branches at a lower level and consequently an earlier production of flowers and bolls. By making the necessary comparative alterations in the daily amount of light it is possible to synchronize the flowering periods of widely divergent varieties and species, and to make crosses hitherto difficult owing to the difference of their flowering seasons in these new regions. Crosses have thus been made between Egyptian cottons with low boll weight and several South American cottons with very large bolls but of short-day and perennial habit.

Within our own Empire, work on the improvement of cottons is also steadily proceeding, but this is too well known here to need repetition.

*Beans.*—New varieties of Soya beans have been produced, suitable for conditions on the Ukraine steppes. Those previously grown proved unsuitable for mechanical harvesting owing to the pods occurring too low down on the plants. Of the new strains produced one is equal in yield to the best imported types and is early maturing, while another provides superior fodder. In Uruguay, where the varieties successful elsewhere have proved failures a collection of 233 varieties from widely different sources and conditions has provided ten promising types. Selected lines of these have given very high yields, and others have been bred which are resistant to drought, which normally has a very adverse effect on germinating qualities, both at harvest and sowing. The best of these new lines have a protein content of 34 to 39 per cent. and oil content of 14 to 20.5 per cent. with a yield up to 1,000 kg. per ha.

This wonder plant, the "staff of life" in the Orient, which provides meal, oil, food for cattle and a fertilizer, has also been successfully introduced into England by careful selection of early maturing varieties and their acclimatization for several years by Mr. J. L. North. The remarkable properties of the Soya bean are not yet appreciated by the British farmer, and a book on the subject has recently been written by Miss F. Bowdidge to make its cultivation more popular. It is to be hoped that its value may soon be realized and taken advantage of by its widespread cultivation.

*Cereals.*—Work steadily proceeds all over the world to produce new improved forms capable of cultivation under diverse conditions, and to provide each district with an ideal variety by hybridizing the highly specialized local cultivated forms and species with the high yielding normal types. The new genera formed by generic crosses between wheat and rye, and wheat and *Aegilops* in Russia and Germany have already been described in this Review (Hurst, 1932), but recently an even more interesting line of investigation has been opened up in the hybridization of wheats with the couch-grass *Agropyrum*. This grass is perennial and it is hoped thus to produce perennial wheats of extreme hardiness for cultivation under adverse conditions. Three species of *Agropyrum* have been successfully used in crosses at Saratov. The first-generation plants are very luxuriant, forming up to 150 heads on one plant. They show a preponderance of *Agropyrum* characters, which is to be expected since *Agropyrum* is a decaploid with 70 chromosomes (10 sets), while *Triticum vulgare* is a hexaploid with 42 chromosomes (6 sets). The hybrids were all perennial and fully resistant to frost, and the first generation of *T. vulgare* crossed with *A. elongatum* is distinguished by excellent fertility, one plant giving as many as 665 grains. Other crosses showed diminishing fertility according to the parentage. In the second generation wide segregation occurred, but the fertility was higher, the grains being large and vitreous. In the third generation many plants showed quite normal fertility, grain being mainly of the wheat type. Several of the hybrids showed resistance to rust and smut, and the freedom from shattering, with the addition of various other valuable characters, and this new breeding work is obviously of great practical importance. It is evident from the results obtained that certain species of couch-grass have a very close affinity with certain wheat species, their distinction apparently lying only in their two extra chromosome sets. Thus *T. vulgare* may be designated A+B+C and *Agropyrum* A+B+C+X+Y, other species of both having variations. Hence it should not be difficult to fix desirable types in future generations, and it is also probable that some fortunate duplications may occur to hasten the process.

The new genus *Secalotriticum* (Rye × Wheat) (or *Triticale*) is already grown on a large scale. The most notable achievement of the Russian grain-breeders, however, is probably the distribution of a very large number of improved varieties of the chief grain crops (wheat, barley, oats and rye) especially suited for cultivation in all the main regions of the Soviet Union, including the arid zones. This has been achieved in the north by the production of ultra-early spring wheats and new hardy winter varieties. One of the new early oats is also highly resistant to drought and rust. The hybrid *Avena sativa*

*A. byzantina* exceeded the standard yield by four times and showed considerable resistance to leaf-rust, and a new rye produced by crossing a local form of Detskoje Selo with Runkler also showed a great increase. Further improvements are still required, however, especially in disease resistance. From a close study of the methods used it may be seen that all the desirable new qualities have been introduced by using local varieties in crossing, since they possess the essential genes for resistance which are needed by the existent varieties.

The Russian world collection of wheats shows that there are four groups of early maturing wheats: (1) Arctic, (2) from continental regions of the sub-tropics, (3) from mountain regions, (4) from countries of periodic rain such as China and Japan. In other respects, however, these wheats are very different: those from the north need little warmth but much light, and those from the south are resistant to heat but need little light. By the requisite crossings early maturing forms can be raised with varying reactions according to the latitude for which they are required.

Great improvements have been carried out in India on wheats and barleys so that they can now compete in quality with any in the world. At Pusa, types resistant to all the three rusts prevalent in India have been produced. In Egypt since 1921, work has been carried out with great success in the improvement of cereal crops by hybridizations between the native forms and imported varieties. In Australia, collections of cereals from all parts of Australia and other countries have been made in order to breed types fitted to all the very varied conditions of the Continent. Three or four hundred valuable new lines have already been isolated and are undergoing exhaustive trials. All European countries as well as America are working on the same genetical lines, and the work done in cereals throughout the world is one of the greatest tributes to the success of modern genetics.

X-ray experiments with wheats show that each variety has its own particular reaction. The soft spring wheats give a great variety of mutants, while the durum varieties give a larger number of mutants but a limited number of types.

In China, work is being done in the hybridization of cultivated rice with the wild forms. A valuable new variety with vigorous growth, resistant to cold and to a high percentage of acidity in the soil, has already been produced. In Japan, experiments with X-rays, ultra-violet rays and temperature changes have induced all known mutants of rice and other new ones, and in some cases mutants ripened 11 days earlier than the parent.

*Lupins*.—The Kaiser Wilhelm Institute have put on the market new alkaloid free lupins which will grow on the most unfavourable light soils and produce extraordinary quantities of green fodder.

Crosses between bitter and sweet lupins showed that absence of alkaloid is a simple recessive. The Russians have also done very much in the production of alkaloid-free lupins, having made two-and-a-half million analyses in two years. The great advantage of these new lupins is their high yield and protein content and their capacity for growing on sandy soils where other crops cannot be produced. A common bitter lupin has been discovered with 21 per cent. oil content against the usual 4 to 6 per cent. and it is hoped to combine this new feature with the alkaloid freedom. Disease resistance is also being investigated.

*Rubber.*—The Russians have made expeditions also to discover new rubber plants suitable for cultivation in their temperate regions. Analyses of 1,048 species of 316 genera belonging to 95 families have been made, and rubber was found in 609 species. The best results were obtained within the *Compositæ* family. A plant found in the Caucasus, *Scorzonera tau-saghyz* showed a higher rubber content than any plant known, the rubber being of high quality and easy to extract. Its unusual capacity for regeneration was also a marked peculiarity of this new species.

*Tobacco.*—In Russia, work is constantly proceeding to combine the hardiness and adaptations of local varieties with the finer flavour of more desirable varieties. Many extremely interesting compound types have been built up containing the chromosome complexes of three species of tobacco. Much segregation occurs, and desirable new types can be fixed in later generations. These synthesized varieties form a valuable reservoir of new and valuable forms, and correspond to the similar experiments in cereals. In America several pure-breeding new species and varieties have been built up in this way, by hybridization followed by chromosome duplication or segregation. The use of ultra-violet rays was found to give rise to conditions of greater fertility in the hybrids. Goodspeed and others find that the tobacco plant is a specially good subject for X-ray treatment, and several useful mutants have arisen by this means. In one case fourteen different types were obtained from a single X-rayed sex cell; seven were pure-breeding derivative types, the others are not yet constant.

Much work has also been carried out with such crops as bananas, sugar-beet, cacao, coconuts, coffee, hemp, potatoes and sugar.

In so short a space it is not possible to deal adequately with any one of the many lines of research being pursued, but enough has been mentioned to show how very much alive scientific plant-breeding is all over the world. Just as new genes are being introduced into existent crops, by the utilization of new species and local forms, so other wild species are being tested and tried out to produce new types of crops. Although the Russians have led the world in the exploitation of world resources, yet there are still untapped reservoirs of wild

plants in the Soviet Union itself, many of which are promising new sources of rubber, fibres, etc. The great forests of South America are still largely unpenetrated by man, and one may expect vast stores of vegetable wealth to be had there for the seeking. Above all in China there is an unparalleled wealth of species and forms, often extremely localized. The intermingling here of tropical and temperate floras has resulted in the evolution of a vegetation of unequalled richness and variety. Our own plant collectors have shown us to some extent the horticultural treasures which are to be found there, but the great store of economic forms is still scarcely touched. Chinese forms are also generally characterized by a happy immunity from disease, and many cold-resistant forms of fruits, etc., which are at best only half hardy in the case of those now in cultivation, exist in the northern mountains and at higher altitudes in the south. Excessively late or early forms, wide variations of colour, form, size, flavour, yield, etc., promise an almost inexhaustible store of genes for the future. Thus we may look forward to a very considerable improvement in all our economic crops, fruits, vegetables, and flowers within the next few years with special adaptations to all the diverse environments of the various continents. The future of plant-breeding is indeed bright, and although much labour will be involved, it will be more than worth while in the usefulness of the results.

*Agriculture and Live-Stock in India, Vol. VII, Part I.*

## Our Exchange List

1. Tropical Life, London.
2. The Modern Review, Calcutta.
3. The Mysore Economic Journal, Bangalore.
4. The Madras Agricultural Journal, Agricultural College, Coimbatore.
5. The Implement and Machinery Review, London.
6. The Journal of the Mysore Engineering Association, Bangalore.
7. The Agricultural Gazette of New South Wales, Sydney.
8. Malayan Agricultural Journal, Federated Malay States, Kuala Lumpur.
9. Review of Applied Entomology, The Imperial Bureau of Entomology, London.
10. Agriculture and Live-Stock in India, Delhi.
11. The Tropical Agriculturist, Peradeniya, Ceylon.
12. Publications of the Department of Agriculture, Colony and Protectorate of Kenya, Nairobi, British East Africa.
13. Bulletin of Deli Proef Station, Medan, Deli (East Coast of Sumatra).
14. International Review of Agriculture, International Institute of Agriculture, Rome, Italy.
15. Publications of the Department of Agriculture and Labour, Government of Porto Rico, San Juan P. R.
16. Lingnan Science Journal, Lingnan University, Hongkok, Canton, China.
17. The Indian Veterinary Science Journal, Madras.
18. Bulletins of Agricultural Experiment Station, State College of Washington, Pullman, Washington.
19. The South African Sugar Journal, Durban, South Africa.
20. Bulletins of the Agricultural Experiment Station, Georgia, U.S.A.
21. Do. do. University of Maryland, Maryland, U.S.A.
22. Do. do. New Brunswick, U.S.A.
23. Do. do. The Pennsylvania State College, Pennsylvania, U.S.A.
24. Do. do. Michigan State College, Michigan, U.S.A.
25. Do. do. University of New Hampshire, Durham, N.H., U.S.A.
26. Do. do. University of Idaho, Idaho, Moscow, U.S.A.

27. Bulletins of the Colorado Experiment Station, Colorado, U.S.A.
28. Do. Missouri College of Agriculture, Columbia,  
Missouri, U.S.A.
29. Do. Agricultural Experiment Station, Stillwater  
(Oklahoma), U.S.A.
30. Do. do University of Arizona, Tucson,  
U.S.A.
31. Do. do Brookings, South Dakota, U.S.A.
32. Bulletins of the Agricultural Experiment Station, La Fayette,  
Indiana, U.S.A.
33. Do. do Gainesville, Florida, U.S.A.
34. Do. do Newark, Delaware, U.S.A.
35. Do. do Fruit Station, Missouri, U.S.A.
36. Do. do Corvallis, Oregon, U.S.A.
37. Do. the Virginia Truck Experiment Station, Nor-  
folk, Virginia, U.S.A.
38. Bulletins of the Agricultural Experiment Station, Pineapple  
Canner's Station, Honolulu, Hawaii, U.S.A.
39. Bulletins of the West Virginia University, West Virginia, U.S.A.
40. Bulletins of the Agricultural Experiment Station, University of  
Nebraska, Lincoln, Nebraska, U.S.A.
41. Do. do University of Montana, Montana,  
U.S.A.
42. Do. do Virgin Islands, U.S.A.
43. Do. do Texas, U.S.A.
44. Union Des Agricultures, D'Egypte, Cairo, Africa.
45. Bulletins of the Virginia Agricultural Experiment Station,  
Blacksbury, Virginia, U.S.A.
46. Bulletins of the Agricultural Experiment Station, Island of Guam,  
Guam, U.S.A.
47. Do. do University of Illinois, Illinois,  
U.S.A.
48. Bulletins of the University Library, University of California,  
Berkeley, California, U.S.A.
49. Philippine Agriculturist, Laguna, Philippine Islands.
50. Bulletins of the State College of Washington, Western Washington  
Experiment Station, Puyallup, Washington, U.S.A.
51. Bulletins of the South Carolina Experiment Station, Clemson  
College, South Carolina, U.S.A.
52. Bulletins of the Agricultural Experiment Station, Logan, Utah,  
U.S.A.
53. The New Zealand Journal of Agriculture, Department of Agri-  
culture, Wellington, New Zealand.

54. The Journal of the Madras Provincial Co-operative Union,  
Madras.
55. Industry, Calcutta.
56. Bulletins of the Department of Agriculture, Canada.
57. Tamil Nadu Co-operative Federation Journal, Coimbatore.
58. Publications of the U.S. Department of Agriculture, Washington,  
U.S.A.
59. Bulletins of the Minnesota Agricultural Experiment Station,  
University Farm, Minnesota, U.S.A.
60. Bulletins of the Imperial Institute, London.
61. Publications of the Imperial Bureau of Soil Science, England.
62. Bulletins of the Rhode Island State College Agricultural Experiment  
Station, Kingston, Rhode Islands, U.S.A.
63. Cyprus Agricultural Journal, Cyprus.
64. Bulletin of the Pan American Union, Washington, D.C., U.S.A.
65. Journal of the Department of Agriculture of Victoria, Melbourne.
66. Bulletins of the Agricultural Experiment Station, Wooster, Ohio,  
U.S.A.
67. Bulletins of the Vermont Agricultural Experiment Station, Bur-  
lington, Vermont, U.S.A.
68. Bulletins of the Imperial Bureau of Fruit Production, England.
69. Publications of the Science Museum, London.
70. Nagpur Agricultural College Magazine, Nagpur, India.
71. Publications of the Indian Central Cotton Committee, Bombay.
72. The Journal of the Jamaica Agricultural Society, Jamaica.
73. Mayurbhanj Gazette, Mayurbhanj State, India.
74. Bulletins of New York State College of Agriculture, Ithaca, New  
York.
75. Bulletins of the Agricultural Experimental Station, New Jersey.
76. Publications of the All Union Scientific Research Cotton Insti-  
tute, 1, Sojuz NIHI, Tashkent, U.S.S.R.
77. Publications of the National Agricultural Research Bureau,  
Nanking 10, China.
78. Publications of the Imperial Bureau of Plant Genetics, School of  
Agriculture, Cambridge.
79. The Indian P.E.N., Malabar Hill, Bombay.